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**ADVANCED COMPOSITES
Work Unit Directive (WUD) 45**

Dr. David B. Curliss



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14. ABSTRACT This final report is a bibliography of technical journal articles, presentations, patents, and reports generated by members of AFRL/MLBC and collaborators. The work was accomplished at Wright-Patterson AFB over a period of 23 years and covers such areas as high temperature organic matrix composites (HTOMC), environmental durability of HTOMCs, intelligent processing of composite materials, process modeling and sensor development for composite materials, multiscale modeling, fiber/matrix interfaces, ply-level fracture mechanics, and mechanics for emerging materials.						
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FOREWORD

The following is a compilation of technical journal articles, presentations, patents, and reports generated by members of AFRL/MLBC and collaborators for the period 1978 – 2001.



DAVID B. CURLISS, Research Leader
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1978

FY78 PRESENTATIONS AND PUBLICATIONS

Presentations:

- T. Hahn: "Fatigue Behavior & Life Prediction of Composite Laminates", presented at the ASTM Symposium of Composite Materials: Testing & Design (5th Symposium), New Orleans, LA, 20-22 March 1978.
- J. Whitney: "Determination of Material Properties for Hybrid Composites", ASTM Committee D-30 Symposium of Composite Materials: Testing & Design, 20-22 March 1978. Coauthored by J. D. Brooks (AFIT), A. N. Pallazotta (AFIT), J. M. Whitney & M. Knight.
- S. Tsai: "Properties of Unidirectional Composites", Composite Materials Computation Workshop at the Univ. of California at Berkeley, 27 March.
- S. Tsai: "Theory of Laminates Composites", Composite Material Computation Workshop at the Univ. of California at Berkeley, 28 March.
- S. Tsai: "Failure Criteria of Composites", Composite Material Computation Workshop at the Univ. of California at Berkeley, 29 March.
- S. Tsai: "Composites Design Methodology", American Institute of Metallurgical Engineers, Detroit, MI, 8 Feb 78.
- S. Tsai: "Pocket Calculations for Composite Materials", Seminar of Department of Aeronautics & Astronautics, MIT, Cambridge, Mass., 22 Feb 78.
- N. Pagano: "Stress Fields in Composite Laminates", Virginia Polytechnic Institute & State Univ. Seminar Series, Blacksburg, VA, 24 March.
- N. Pagano: "Stress Fields in Composite Laminates", Cornell Univ. Seminar Series, Ithaca, NY, 29 March.
- N. Pagano: "Thermostructural Response of Rosette Cones Under Axisymmetric Loading", presented at JANNAF Propulsion Meeting, Incline Village, Nevada, 16 Feb 78.
- S. Tsai: "Composite Materials Computation Workshop", Rensselaer Polytechnic, Troy, NY, based on AFML-TR-78-33, Composite Materials Workbook, April 15, 1978.
- T. Hahn: "Formulas for Micromechanics", SAMPE, Disneyland Hotel, Anaheim, CA, based on AFML-TR-78-33, Composite Materials Workbook, May 3, 1978.

Presentations (Cont'd)

- L. Drzal: "Surface Properties of Graphite Reinforcing Fibers, ACS Boston, July 1978.
- L. Drzal: "Relationship of Graphite Fiber Surface Chemistry to Interfacial Strength", The Adhesion Society, Savannah, February 1979.
- G. Husman: "G. E., "Development of Molecular Composites", Ordered Polymers Meeting at Imperial House North, Dayton, OH, AF & AF contractors only, 24 May 1978.
- C. Browning: SAMPE, "HME Resin Matrix Composites", Anaheim, CA, 3 May 1978.
- C. Browning: International Conference on Composite Materials, "Mechanisms of Moisture Induced Property Losses in Epoxy Resins and Composites", Toronto, Canada, 16 April 1978.

AFML Technical Reports:

- S. Tsai: "Composite Materials Workbook", AFML-TR-78-33, February 1978.
- H. T. Hahn: "Swelling of Composite Laminates", AFML-TR-77-199, Oct 1977.
- H. T. Hahn: "Representation of Matrix/Interface-Controlled Strength of Unidirectional Composites", AFML-TR-78-85.
- J. Whitney: "Mechanics of Composites Review", Oct 1978.
- H. T. Hahn: "Fatigue Behavior and Life Prediction of Composite Laminates", AFML-TR-78-43, April 1978.
- L. Drzal: "Proceeding of Interphase Workshop", Milestone No. 11, AFML-TR-77-129.

Other Publications:

- L. Drzal: "Graphite Fiber-Epoxy Interfacial Defect Analysis", Int. Metallographic Exhibit, June 1978, Montreal, Canada.
- L. Drzal: "Surface Composition and Energetics of Type HM Graphite Fibers", submitted to CARBON, Milestone No. 12.
- L. Drzal: "A Photomicroscopic Technique for the Analysis of the Composite Interphase Under Mechanical Stress", Int. Metallographic Exhibit, June 1978, Montreal, Canada.

Other Publications (Cont'd)

- J. Whitney: "Moisture Diffusion in Fiber Reinforced Composites", Proceedings of the Second International Conference on Composite Materials, the Metallurgical Society of AIME, New York, New York, 1978, pp. 1584-1601.
- N. Pagano: "Free Edge Stress Fields in Composite Laminates", Int. J. Solids Structures, 1978, Vol. 14, pp. 401-406.
- N. Pagano: "Stress Fields in Composite Laminates", Int. J. Solids Structures, 1978, Vol. 14, pp. 385-400.
- J. Whitney & G. Husman "Use of the Flexure Test for Determining Environmental Behavior of Fibrous Composites", Experimental Mechanics, Vol. 18, No. 5, May 1978, pp. 185-190.

1979

FY-79 PRESENTATIONS, PUBLICATIONS AND PATENTS

Presentations:

J. M. Whitney, "Failure Criteria for Notched Composites," presented at Gordon Research Conference on the Deformation and Failure Mechanisms in Polymers and Composites, Santa Barbara, California, January 22-26, 1979.

J. M. Whitney, "Fatigue Characterization of Composite Materials," presented at ASTM Symposium on Fatigue of Fibrous Composite Materials, San Francisco, California, May 22-23, 1979.

J. M. Whitney and M. Knight, "The Relationship Between Tensile Strength and Flexure Strength in Fiber-Reinforced Composites," presented SESA Spring Meeting, San Francisco, California, May 20-25, 1979.

N. J. Pagano and E. L. Stanton, "A New Approach to Ply Pattern Analysis," presented at Conference on Analysis and Fabrication of Carbon-Carbon Involute Exit Cones, Dayton, Ohio, February 21-22, 1979.

F. K. Huber and N. J. Pagano, "Effects of Process Defects in Thick Composites," presented at Conference on Analysis and Fabrication of Carbon-Carbon Involute Exit Cones, Dayton, Ohio, February 21-22, 1979.

L. Drzal, "The Relationship of Graphite Fiber Surface Chemistry to Interfacial Strength," presented at The Adhesion Society, Savannah, Georgia, February 1979.

L. Drzal, "Relationship of Contact Angle Measurements to Surface Composition through ESCA Measurements," presented at AFML/AFOSR Surface Symposium, June 1979.

S. W. Tsai, "Lectures in Mechanics of Composite Materials, presented at Composite Materials Computation Workshop: A Practical Guide to Design and Testing, University of California, Berkeley, March 26-30, 1979.

S. W. Tsai, "Simplified Design of Composites," SAMPE Regional Meeting, Orlando, Florida, March 15, 1979.

S. W. Tsai and H. T. Hahn, "Role of Interface in the Strength of Composite Materials," ACS Meeting, Honolulu, Hawaii, April 2-8, 1979.

S. W. Tsai, "Anisotropic Strength of Composite Materials," presented at University of Delaware Graduate Seminar, Newark, Delaware, April 27, 1979.

M. Von Kuzenko and C. E. Browning, "Dynamic Characterization of an Advanced Composite Epoxy Matrix Resin of Altered Composition," presented at ACS Meeting, Honolulu, Hawaii, April 2-8, 1979.

G. E. Husman, T. Helminiak, W. Adams, D. Wiff, and C. Benner, "Molecular Composites - Rodlike Polymer Reinforcing an Amorphous Polymer Matrix," presented at ACS Meeting, Honolulu, Hawaii, April 2-8, 1979.

G. E. Husman, "Molecular Composites;" Ordered Polymers Review, Dayton, Ohio, October 1978.

K. Knoll, "Development of a Library Module for the Analysis of Advanced Composite Materials," presented at Symposium on Advanced Composites: Design and Applications, National Bureau of Standards, Gathersburg, Maryland, May 23-25, 1979.

G. E. Husman and J. T. Husman, "Polyphenyl Sulfane Matrix Composites," 24th National SAMPE Symposium and Exhibition, San Francisco, California, May 8-10, 1979.

S. Schulman, "Thermal Conductivity of Carbon/Graphite Fibers," Gordon Research Conference, July 1979.

AFML Technical Reports:

S. W. Tsai, H. T. Hahn, and F. Huber, Magnetic Card Calculator Solutions to Composite Materials, AFML-TR-77-50, January 1979.

S. W. Tsai and H. T. Hahn, TI-59 Magnetic Card Calculator Solutions to Composite Materials Formulas, AFML-TR-79-4040, April 1979.

S. W. Tsai and H. T. Hahn, Introduction to Composite Materials, Volume 1: Deformation of Unidirectional and Laminated Composites, AFML-TR-78-201, Volume 1, January 1979.

Won J. Park, Basic Concepts of Statistics and Their Applications in Composite Materials, AFML-TR-79- , April 1979.

Open Literature Publications

J. M. Whitney and C. E. Browning, "Some Anomalies Associated with Moisture Diffusion in Epoxy Matrix Composite Materials," Advanced Composite Materials - Environmental Effects, ASTM STP 658, American Society for Testing and Materials, Philadelphia, PA, 1979, pp. 43-60.

C. E. Browning, "The Mechanisms of Elevated Temperature Property Losses in High Performance Structural Epoxy Resin Matrix Materials After Exposures to High Humidity Environments," Proceedings of the Second International Conference on Composite Materials, American Institute of Mining, Metallurgical, and Petroleum Engineers, New York, 1978, pp. 1527-1543.

M. Von Kuzenko and C. E. Browning, "Dynamic Mechanical Characterization of an Advanced Epoxy Matrix Resin of Altered Composition," Organic Coatings and Plastics Chemistry, American Chemical Society, Vol. 40, 1979, pp. 694-699.

G. E. Husman, T. Helminiak, W. Adams, D. Wiff, and C. Benner, "Molecular Composites - Rodlike Polymer Reinforcing an Amorphous Polymer Matrix," Organic Coatings and Plastics Chemistry, American Chemical Society, Vol. 40, 1979, pp. 797-802.

S. W. Tsai and H. T. Hahn, "Role of Interface in the Strength of Composite Materials," Organic Coatings and Plastic Chemistry, American Chemical Society, Vol. 40, 1979, pp. 512-514.

G. E. Husman and J. T. Hartness, "Polyphenyl Sulfane Matrix Composites," Society for the Advancement of Material and Process Engineering, Vol. 24, 1979, pp. 21-31.

L. Drzal, "The Surface Composition and Energetics of Type HM Graphite Fibers," Carbon, accepted for publication.

N. J. Pagano and P. W. Hsu, "Geometric Analysis of Rosette Exit Cones," Journal of Spacecraft and Rockets, July 1979.

1980

FY-80 PRESENTATIONS, PUBLICATIONS, AND PATENTS:

Presentations:

1. F. Huber and N. J. Pagano, "The Experimental Determination of Shear Moduli of Orthotropic Composites," presented at ASTM Symposium on Test Methods and Design Allowables, Dearborn, Michigan, October 1979.
2. E. L. Stanton and N. J. Pagano, "Curing Stress Fields in Involute Exit Cones," presented at ASME Winter Annual Meeting, New York, N.Y., December 1979.
3. N. J. Pagano, "Exact Involute Exit Cones," JANNAF, Monterey, CA, March 1980.
4. S. Soni, "Failure Analysis of Composite Laminates with a Fastener Hole," ASTM Symposium on Joining of Composite Materials, Minneapolis, Minnesota, April 1980.

5. Karyn Knoll, "TI-59 Programs for Analysis of Composite Materials," International Conference on Composite Materials III, Paris, France, August 1980.

Technical Reports:

1. Karyn Knoll, 'TI-59 Magnetic Tape Programs for Analysis of Advanced Composite Materials,' AFWAL-TR-80-4019, May 1980.
2. Karyn Knoll, "Instructions for Use of the Composite Module I," AFWAL-TR-80-4046, May 1980.
3. Karyn Knoll, "Development of a Library Module for the Analysis of Advanced Composite Materials," Advanced Composite Design and Applications, NBS Special Publication 563, November 1979.
4. J. M. Whitney, "Fatigue Characterization of Composite Materials," AFWAL-TR-79-4111, October 1979.
5. J. M. Whitney and M. Knight, "The Relationship Between Tensile Strength and Flexure Strength in Fiber Reinforced Composites," AFWAL-TR-80- , to be published before end of FY-80.

Open Literature Publications:

1. L. T. Drzal, "Graphite Fiber Surface Analysis by ESCA and Polar/Dispersion Free Energy Analysis," Applications of Surface Science, Vol. 4, 1980, pp 340-355.
2. L. T. Drzal, M. J. Rich, J. D. Camping, and W. J. Park, "Interfacial Shear Strength and Failure Mechanisms in Graphite Fiber Composites," Proceedings of 35th RP/C, 1980, Section 20-C.
3. Karyn Knoll, "The Promise and Problems of Advanced Composites," Aerospace Metals and Machines, March 10, 1980.
4. S. W. Tsai and H. T. Hahn, Introduction to Composite Materials, Technomic Publishing Co., Stamford, Conn., 1980.
5. S. W. Tsai and H. T. Hahn, "Role of the Interface in the Strength of Composite Materials," Adhesion and Adsorption of Polymers, Part B, Edited by Lieng-Huang Lee, Plenum Publishing Corp., New York, N.Y., 1980, pp 463-472.
6. M. Von Kuzenko, C. E. Browning, and C. E. Fowler, "Dynamic Mechanical Characterization of Advanced Composite Matrix Resins of Altered Composition," Advances in Chemistry Series, to be published.
7. E. L. Stanton and N. J. Pagano, "Curing Stress Fields in Involute Exit Cones," Modern Developments in Composite Materials and Structures, ASME, December 1979.

8. J. M. Whitney and M. Knight, "The Relationship Between Tensile Strength and Flexure Strength in Fiber Reinforced Composites," Experimental Mechanics, June 1980.

1981

FY81 PRESENTATIONS

(1) G. E. Husman and J. T. Hartness, "Acetylene Terminated Sulfone Resin Development", 12th SAMPE Symposium and Technical Conference, Seattle, Washington, October 1980.

(2) L. T. Drzal, "Surface Characterization of Graphite Fibers", DOD/TTCP Critical Review: Techniques for the Characterization of Composite Materials, MIT, Cambridge, Massachusetts, June 1981.

(3) L. T. Drzal, M. J. Rich and P. Lloyd, "Interphase Effects on Fiber-Matrix Adhesion", ACS Meeting, New York, New York, 1981.

(4) L. T. Drzal, M. J. Rich and D. L. Hall, "Structure-Property Relationships at the Composite Interphase" 15th Carbon Conference, University of Pennsylvania, June 1981.

(5) L. T. Drzal, "Molecular Aspects of Fiber-Matrix and Their Effect on Interfacial Shear Strength", Gordon Conference on Composite Materials, Santa Barbara, California, January 1981.

(6) N. Balasubramanian, "The First-Ply Failure Surface of Laminated Composites", 6th ASTM Conference on Composite Materials: Testing and Design, Phoenix, Arizona, May 1981.

(7) J. M. Whitney, "Use of the Lognormal Distribution for Characterizing Composite Materials", 6th ASTM Conference on Composite Materials: Testing and Design, Phoenix, Arizona, May 1981.

FY81 PUBLICATIONS

(1) L. T. Drzal, "Surface Characterization of Graphite Fibers", Proceedings of DOD/TTCP Critical Review: Characterization of Composite Materials, 1981.

(2) L. T. Drzal, M. J. Rich and D. L. Hall, "Structure-Property Relationships at the Composite Interphase", Proceedings of the 15th Carbon Conference, June 1981.

(3) L. T. Drzal, M. J. Rich, and P. Lloyd, "Interphase Effects on Fiber-Matrix Adhesion", American Chemical Society Reprints, 1981.

(4) G. E. Husman and J. T. Hartness, "Acetylene Terminated Sulfone Resin Development", Proceedings of 12th National SAMPE Symposium and Technical Conference, 1980.

(5) J. M. Whitney, "Fatigue Characterization of Composite Materials", Fatigue of Fibrous Composite Materials, ASTM STP 723, American Society for Testing and Materials, Philadelphia, 1981, pp. 133-151.

(6) S. W. Tsai, "Generalized Stress-Strain Relations for Laminated Composites", Composite Technology Review, to be published.

1982

FY 82 PRESENTATIONS:

- (1) C. E. Browning, F. L. Abrams, and J. M. Whitney, "A Four-Point Shear Test for Graphite/Epoxy Composites," presented at ASTM Meeting on Producability and Quality Assurance of Composite Materials, St. Louis, MO, October 1981.

- (2) J. M. Whitney, "A Residual Strength Model for Competing Failure Modes," presented at ASTM Meeting on Long-Term Behavior of Composites, Williamsburg, VA, March 1982.
- (3) N. J. Pagano, and S. R. Soni, "A Global-Local Model for Stresses in Composite Laminates," presented at Eleventh Southeastern Conference on Theoretical and Applied Mechanics, The University of Alabama in Huntsville, Huntsville, AL, April 1982.
- (4) N. J. Pagano, and S. R. Soni, "Global-Local Model for Investigating Delamination in Composite Laminates," presented at AIAA 8th Mini-Symposium on Aerospace Science and Technology, Air Force Institute of Technology, Wright-Patterson Air Force Base, OH, March 1982.
- (5) S. L. Donaldson, "Sensitivity Study on Modified Rule-of-Mixtures Relations for Composite Materials," presented at AIAA 8th Mini-Symposium on Aerospace Science and Technology, Air Force Institute of Technology, Wright-Patterson Air Force Base, OH, March 1982.
- (6) J. M. Whitney, "Notch Strength of Composites," presented at Workshop on Failure Analysis of Composite Materials, NASA Langley Research Center, Hampton, VA, March 1982.
- (7) L. T. Drzal, "Dependence of Fiber-Matrix Failure Modes in Interphase Properties," presented at Mechanics of Composites Review, Dayton, OH, October 1981, (also at Union Carbide Parma Technical Center, November 1982; and at Department of Materials Science, University of Cincinnati, October 1981).
- (8) L. T. Drzal, "The Effect of Adhesion on the Interfacial Failure Mode in Graphite Fiber-Epoxy Composites," Adhesion Society Meeting, Mobile, AL, February 1982.
- (9) L. T. Drzal, "Composite Interface Fracture: Effect of Graphite Fiber/Epoxy Matrix Adhesion," presented at Symposium on Fracture of Polymers and Composites, University of Akron, Akron, OH, May 1982.
- (10) N. Balasubramanian, "A Method for Optimization of Composite Materials," presented at Mechanics of Composites Review, Dayton, OH, October 1982.
- (11) M. Knight, "The Determination of Interlaminar Moduli of Graphite/Epoxy Composites," presented at Mechanics of Composites Review, Dayton, OH, October 1982.
- (12) S. W. Tsai, "Demonstration of Computer Programs for Composite Laminate Analysis," presented at Mechanics of Composites Review, Dayton, OH, October 1982.

FY 82 PUBLICATIONS:

- (1) J. M. Whitney, I. M. Daniel, and R. B. Pipes, Experimental Mechanics of Fiber Reinforced Composite Materials, Society for Experimental Stress Analysis (SESA), 1982.

(2) M. Knight, "Three-Dimensional Elastic Moduli of Graphite/Epoxy Composites," Journal of Composite Materials, Vol. 16, March 1982, pp.153-159.

(3) S. W. Tsai, "Strength Ratios of Orthotropic Materials," Proceedings of Euromech Colloquim, Applied Sciences, 1982.

1983

FY83 PRESENTATIONS:

- (1) J. M. Whitney and C. E. Browning, "Materials Characterization for Matrix Dominated Failure Modes", ASTM Symposium on Effects of Defects in Composite Materials, San Francisco, California, December 13-14, 1982.
- (2) J. M. Whitney, "Characterization of Interlaminar Fracture Toughness", Eighth Annual Mechanics of Composites Review, Dayton, Ohio, October 5-7, 1982.
- (3) M. D. Kistner, J. M. Whitney, and C. E. Browning, "First Ply Failure of Graphite/Epoxy", Second US/Japan Symposium on Composite Materials, NASA Langley Research Center, June 6-8, 1983.
- (4) L. T. Drzal, "Effect of Graphite Fiber/Epoxy Adhesion on Composite Fracture Behavior", Second US/Japan Symposium on Composite Materials, NASA Langley Research Center, June 6-8, 1983.
- (5) J. M. Whitney, "Buckling of Anisotropic Laminated Cylindrical Plates", AIAA Structures, Materials, and Dynamics Conference, Lake Tahoe, Nevada, May 2-4, 1983.
- (6) L. T. Drzal, "Composite Interphase Characterization", 28th SAMPE Meeting, Anaheim, California, April 1983.
- (7) L. T. Drzal, M. Rich, and M. Koenig, "Moisture Induced Interfacial Effects on Graphite Fiber-Epoxy Interfacial Shear Strength", 38 SPI/RPC Conference, Houston, Texas, February 1983.
- (8) V. B. Gupta, L. T. Drzal, Y. L. Chen, "A Study of the Fracture Surface of Cured Epoxy Resins", 41st EMSA Meeting, Phoenix, 1983.
- (9) V. B. Gupta, L. T. Drzal, and R. Omlor, "A Modified Replication Technique to Study the Morphology of Cured Epoxy Resins", 41st EMSA Meeting, Phoenix, 1983.

- (10) V. B. Gupta, L. T. Drzal, W. W. Adams, and Omlor, "The Morphology of a Cured Epoxy Resin as Revealed by Electron Microscopy", Electron Microscopy Workshop on Polymers, Boston, 1983.
- (11) V. B. Gupta, L. T. Drzal, C. Y. C. Lee, and M. J. Rich, "The Effect of Moisture on the α Relaxation of Cured Epoxy Resin", 185th National ACS Meeting, Seattle, Washington, March 20-25, 1983.
- (12) C. E. Browning, "Composite Materials Characterization and Development at AFWAL", Tough Composite Materials Workshop, NASA Langley Research Center, May 24-26, 1983.
- (13) L. T. Drzal, "Composite Property Dependence on the Fiber, Matrix, and Interphase", Tough Composite Materials Workshop, NASA Langley Research Center, May 24-26, 1983.

(14) F. L. Adams and C. E. Browning, "Influence of Molecular Structure on Mechanical Properties of Acetylene Terminated Resins", 185th National ACS Meeting, Seattle, Washington, March 20-25, 1983.

(15) D. Nichols, "Delamination of G_{IC} in Angle-Ply Composites Using a Double Cantilever Beam Test Method", AIAA 9th Annual Dayton Cincinnati Section Mini-Symposium on Aerospace Science and Technology, Dayton, Ohio, March 22, 1983.

FY83 PUBLICATIONS:

(1) C. E. Browning, F. L. Abrams, and J. M. Whitney, "A Four-Point Shear Test for Graphite/Epoxy Composites", Composite Materials: Quality Assurance and Processing, ASTM STP 797, C. E. Browning, Editor, American Society for Testing and Materials, 1983, pp. 54-74.

(2) J. M. Whitney, C. E. Browning, and W. Hoogsteden, "A Double Cantilever Beam Test for Characterizing Mode I Delamination of Composite Materials", Journal of Reinforced Plastics and Composites, Vol. 1, October, 1982, pp. 297-313.

(3) D. J. Nicholls and J. P. Gallagher, "Determination of G_{IC} in Angle-Ply Composites Using a Cantilever Beam Test Method", Journal of Reinforced Plastics and Composites, Vol. 2, January 1983, pp. 2-17.

(4) J. M. Whitney, "Use of the Lognormal Distribution for Characterizing Composite Materials", Composite Materials: Testing and Design (Sixth Conference), ASTM STP 787, I. M. Daniel, Editor, American Society for Testing and Materials, 1982, pp. 483-497.

(5) F. L. Abrams and C. E. Browning, "Influence of Molecular Structure on Mechanical Properties of Acetylene Terminated Resins", Organic Coatings and Applied Polymer Science Proceedings, Vol. 48, American Chemical Society, 1983, pp. 909-911.

(6) N. J. Pagano and S. R. Soni, "Global-Local Laminate Variational Model", International Journal of Solids and Structures, Vol. 19, March 1983, pp. 207-228.

(7) L. T. Drzal, "Composite Interphase Characterization", Proceedings 28th SAMPE Meeting, Anaheim, California, 1983.

(8) L. T. Drzal, M. J. Rich, P. F. Lloyd and M. Koenig, "Adhesion of Graphite Fibers to Epoxy Matrices. II The Effect of Fiber Finish", Journal of Adhesion (in review).

(9) L. T. Drzal, M. Rich and M. Koenig, "Moisture Induced Interfacial Effects on Graphite Fiber-Epoxy Interfacial Shear Strength", Proceedings 38th SPI/RPC Conference, Houston, 1983.

(10) V. B. Gupta, L. T. Drzal, Y. L. Chen, "A Study of the Fracture Surface of Cured Epoxy Resins", Proceedings 41st EMSA Meeting, Phoenix, 1983.

(11) V. B. Gupta, L. T. Drzal and R. Omlor, "A Modified Replication Technique to Study the Morphology of Cured Epoxy Resins", Proceedings 41st EMSA Meeting, Phoenix, 1983.

(12) V. B. Gupta, L. T. Drzal, W. W. Adams and R. Omlor, "The Morphology of a Cured Epoxy Resin as Revealed by Electron Microscopy", Proceedings Electron Microscopy Workshop on Polymers", Boston, 1983.

(13) V. B. Gupta, L. T. Drzal, C. Y. C. Lee and M. J. Rich, "The Effect of Moisture on the α Relaxation of Cured Epoxy Resin", ACS Meeting, Washington, 1983.

1984

FY84 PRESENTATIONS:

- (1) J. M. Whitney and M. Knight, "A Modified Free-Edge Delamination Specimen," presented at ASTM Symposium on Delamination and Debonding of Materials, Pittsburgh, Pennsylvania, November 1983.
- (2) L. T. Drzal, "Interface Response to Hygrothermal Environment," Gordon Research Conference on Composites, Santa Barbara, California, January 1984.
- (3) L. T. Drzal, M. J. Rich, and M. F. Koenig, "Graphite Fiber Finish and its Interaction with Moisture, Temperature, and Stress," Adhesion Society, Jacksonville, Florida, February 1984.
- (4) D. P. Anderson, J. T. Hartness, W. D. Adams, D. J. Nicholls, and S. Kumar, "Properties and Morphology of Polyetheretherketone Composites," Symposium on Chemo-Processing of High Performance Composites, National ACS Meeting, St. Louis, Missouri, April 1984.
- (5) D. P. Anderson, J. T. Hartness, W. D. Adams, D. J. Nicholls, and S. Kumar, "Properties and Morphology of Polyetheretherketone Composites," Poster Session, National American Physical Society Meeting, Detroit, Michigan, March 1984.
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- (7) D. J. Nicholls, "The Effect of Stress Biaxiality on the Transverse Tensile Strain-to-Failure of Composites," ASTM Symposium on Composite Materials: Testing and Design (7th Conference), Philadelphia, Pennsylvania, April 1984.
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- (9) M. Knight, "An Edge Delamination Test for Fracture in Composite Materials," AIAA 10th Annual Dayton Cincinnati Section Mini-Symposium on Aerospace Science and Technology, Dayton, Ohio, March 1984.
- (10) L. T. Drzal and M. J. Rich, "Carbon Fiber-Epoxy Interphase Properties," International Carbon Conference, Bordeaux, France, July 1984.
- (11) L. T. Drzal, M. J. Rich, "Hygrothermal Effects on a Modified Carbon Fiber-Epoxy Interphase," International Carbon Conference, Bordeaux, France, July 1984.
- (12) J. M. Whitney and C. E. Browning, "On Interlaminar Beam Experiments for Composite Materials," V International Congress on Experimental Mechanics, Montreal, Canada, June 1984.
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- (1) J. M. Whitney, "On Short Beam Shear Tests for Composite Materials", Mechanics of Composites Review, Dayton, Ohio, October 23-25, 1984.

- (2) J. Reichman, "An Evaluation of Narmco 5245/AS-6 Bismaleimide", AFNSES 1984 Symposium, Norfolk, Virginia, November 14-16, 1984.
- (3) J. Reichman, F. Abrams, and C. Browning, "Determining the Toughness of Brittle Matrix Composites", ASTM Symposium on Toughened Composites, Houston, Texas, March 13-15, 1985.
- (4) H. S. Schwartz and J. T. Hartness, "Effect of Fiber Coatings on Interlaminar Fracture Toughness of Composites", ASTM Symposium on Tough Composites, Houston, Texas, March 13-15, 1985.
- (5) J. M. Whitney and L. T. Drzal, "Three-Dimensional Stress Distribution Around an Isolated Fiber Fragment", ASTM Symposium on Tough Composites, Houston, Texas, March 13-15, 1985.
- (6) W. W. Adams, D. P. Anderson, J. T. Hartness, D. J. Nicholls, and S. Kumar, "Properties and Morphology of Polyetheretherketone Composites", Symposium on Chemo-Processing of High Performance Composites, ACS Meeting, St Louis, Missouri, April 9, 1985.
- (7) J. M. Whitney, "Stress Analysis of a Mode I Edge Delamination Specimen for Composite Materials", AIAA/ASME/ASCE/AHS 26 Structures, Structural Dynamics, and Materials Conference, Orlando, Florida, April 15-17, 1985.
- (8) C. E. Browning, "Processing Science of Epoxy Resin Composites", American Institute of Chemical Engineers Meeting, Seattle, Washington, August 26-28, 1985.
- (9) J. M. Whitney, "Delamination in Composite Materials", 19th Midwestern Mechanics Conference, The Ohio State University, Columbus, Ohio, September 9-11, 1985.
- (10) N. J. Pagano, "Global-Local Model for Composite Failure Analysis", 19th Midwestern Mechanics Conference, The Ohio State University, Columbus, Ohio, September 9-11, 1985.

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- (2) J. M. Whitney, "Damage Tolerance of Composites: Delamination Characterization", presented at Thermoplastics Workshop, San Diego, CA, February 1986.
- (3) J. M. Whitney, "Delamination Characterization in Composites", presented at ASTM Mini-Symposium on Fracture Testing of Composite Materials - State-of-the-Art, Charleston, South Carolina, April 28, 1986.
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- (4) Cordell, T.M., "Semicrystalline and Amorphous Thermoplastic Matrix Composites", American Chemical Society, New York, NY, April 1986.
- (5) Browning, C.E. and Cordell, T.M. "Advances in Thermoplastic Composites", American Chemical Society, New York, NY, April 1986.
- (6) C. Y-C Lee, "Torsion Impregnated Cloth Analysis" American Chemical Society, New York, NY, April 1986.
- (7) C. Y-C Lee and C. S. Wang, "Tensile Degradation of Acetylene Terminated Imide" SAMPE National Conference, Las Vegas, NV, April 1986.
- (8) L. R. Denny, I. J. Goldfarb and C. Y-C Lee, "Acetylene Terminated Resin Technology Development", SAMPE National Conference, Las Vegas, NV, April 1986.
- (9) V. H. Kenner and C. Y-C Lee, "Some Results of Fatigue Tests on a Brittle Polymer", Society of Engineering Science, Blacksburg, VA, Oct

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(10) H. H. Chuah, C. Y-C Lee and T. Helminiak, "Bulk Coagulation of Poly(benzobisthiazole)/nylon Molecular Composite", American Physical Society, Las Vegas, NV, April 1986.

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- (2) J. M. Whitney and M. Knight, "A Residual Stress Free Mode I Edge Delamination Specimen," presented at *ICCM VI/ECCM2 Conference*, London, England, July 20-24, 1987.
- (3) J. M. Whitney, "The Effect of Shear Deformation on the Bending and Buckling of Anisotropic Laminated Plates," presented at *Fourth International Conference on Composite Structures*, Paisley, Scotland, July 27-29, 1987.
- (4) J. M. Whitney and S. R. Short, "A Modified Short Beam Shear Test," presented at *American Society for Composites/University of Delaware Center for Composite Materials Science and Engineering*, University of Delaware, September 23-25, 1987.
- (5) J. M. Whitney, J. W. Gillespie, Jr., and L. A. Carlsson, "Singularity Approach to the Analysis of the End Notch Flexure Specimen," presented at *American Society for Composites/University of Delaware Center for Composite Materials Symposium on Composite Science and Engineering*, University of Delaware, September 23-25, 1987.

- (6) S. L. Donaldson, "Interlaminar Fracture Due to Tearing (Mode III)," presented at *ICCM VII/ECCM2 Conference*, London, England, July 20-24, 1987.
- (7) M. F. Hudock, "Low Velocity Impact Testing of Composite Materials," presented at *ASME Student Regional Conference*, West Virginia University, March 1987.
- (8) M. F. Hudock, "Low Velocity Impact Testing," presented at *AIAA Student Conference*, Dayton, OH, April 1987.
- (9) K. N. Ptak, K. M. Gupte, C. Y-C Lee, and H. H. Chuah, "Direct Block Coagulation of PBT/Nylon 66 Molecular Composite," presented at *American Chemical Society National Meeting*, New Orleans, LA, August 1987.
- (10) C. Y-C Lee, H. M. Burte, and C. E. Browning, "Unified Life Cycle Engineering in Composite," presented at *American Society of Composites*, Dayton, OH, October 7-9, 1986.
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- (13) K. Ptak and C. Y-C Lee, "Direct Block Coagulation," presented at *Ordered Polymer Conference*, Dayton, OH, November 1986.
- (14) C. Leung, T. Liao and C. Y-C Lee, "Effects of Acetylene Terminated Additives on the Properties of ATS Tertiary Blends," presented at *American Chemical Society National Meeting*, New Orleans, LA, August 1987.
- (15) D. Carlin, "High Temperature Thermoplastic Materials Characterization," presented at the *Fourth Industry/Government Review of Thermoplastic Matrix Composites*, San Diego, CA, February 1987.
- (16) D. Carlin, "High Temperature Thermoplastic Matrix Evaluation," presented at *13th Annual Minisymposium on Aerospace Science and Technology, AIAA*, Dayton, OH, March 1987.
- (17) D. Carlin, "Advanced Thermoplastic Composite Technology, An Air Force Overview," presented at *Composites: Thermoplastic Composite Manufacturing Conference*, Wichita, KS, March 1987.
- (18) D. Carlin, "Air Force Thermoplastic Composites Overview," presented at the *SAMPE Conference: Thermoplastics III: Advanced Composite Applications*, Long Beach, CA, August 1987.
- (19) C. W. Lee, "Expert System Controlled Curing of Composites,: presented at *1st Meeting of American Society for Composites Conference*, Dayton, OH, October 7-9, 1986.
- (20) F. Abrams, C. Browning, P. Garrett, T. Lagnes, S. LeClair, C. W. Lee and R. Servais, "Qualitative Process Automation: Industry Review," presented at Wright-Patterson AFB, OH, July 23, 1987.

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(22) F. Abrams, "Knowledge Base for Expert System Process Control/Optimization," presented at *ASM Polymer Composite Materials and Processing Conference*, Cincinnati, OH, October 13-15, 1987.

(23) F. Abrams, "Intelligent Processing Using Qualitative Process Automation," presented at *JANNAF Rocket Nozzle Technology Subcommittee Meeting*, NASA Marshall Space Flight Center, AL, October 21, 1987.

(24) F. Abrams, "An Expert System Process Controller for Advanced Composites," presented at *Regional Technical Conference of the Society of Plastics Engineers*, Detroit, MI, November 2-4, 1987.

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1. R. Y. Kim and N. J. Pagano, "A Study of Fiber-Matrix Interfacial Modeling" *Fourth Japan/US Conference on Composite Materials*, Washington D. C., June 1988.
2. R. Y. Kim and N. J. Pagano, "Initiation of Damage in Unidirectional Brittle Matrix Composites", *Fourth Japan/US Conference on Composite Materials*, Washington D. C., June 1988.
3. N. J. Pagano and L. Dharani, "Comparison of Failure Models for Brittle Matrix Composites", *ASME Winter Annual Meeting*, Boston, MA, December 1987.
4. N. J. Pagano, "Transverse Damage in Brittle Matrix Composites", *Annual Meeting, Society of Engineering Science*, Berkeley, CA, May 1988.
5. H. W. Brown, "Analysis of a Modified Free-Edge Delamination Specimen", *American Society for Composites, Third Technical Conference*, Seattle, WA, September 1988.
6. J. M. Whitney, "Analysis of the End Notch Flexure Specimen Using a Higher Order Beam Theory Based on Reissner's Principle", *American Society for Composites, Third Technical Conference*, Seattle, WA, September 1988.
7. R. Y. Kim, F. L. Abrams, and M. Knight, "Mechanical Characterization of a Thick Composite Laminate", *American Society for Composites, Third Technical Conference*, Seattle, WA, September 1988.
8. R. D. Kurtz and J. M. Whitney, "Torsion of Laminates Containing Orthotropic Layers", *American Society for Composites, Third Technical Conference*, Seattle, WA, September 1988.

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7. S. L. Donaldson, "Mode III Interlaminar Fracture Characterization of Composite Materials", *Composite Science and Technology*, Vol. 32 (1988), pp. 225-249.

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2. J. M. Whitney, "A Simplified Accurate Strain Energy Release Rate Analysis of the End Notch Flexure Specimen for Composite Materials", presented at *34th International SAMPE Symposium and Exhibit*, Reno, NV, May 8-11, 1989.
3. J. M. Whitney, "Application of Higher Order Plate Theories to the Delamination Analysis of Composite Materials", presented as part of a panel on Composites and Laminated Plates and Shells, *AIAA/ASME/ASCEAH/ASC 30th Structures, Structural Dynamics and Materials Conference*, Mobile, AL, April 3-5, 1989.
4. J. M. Whitney and M. Knight, "Effect of Residual Stresses on Edge Delamination in Composite Materials", presented at *AIAA/ASME/ASCEAH/ASC 30th Structures, Structural Dynamics and Materials Conference*, Mobile, AL, April 3-5, 1989.
5. S. Gunderson and R. Schiavone, "The Insect Exoskeleton as Compared to Man-Made Advanced Composites", presented at *AIAA 15th Annual Mini-Symposium*, Dayton, OH, March 31, 1989.
6. P. R. Wagner, "Use of the Four Point Flex Test for Examining the Compression Stress-Strain Behavior of Unidirectional Composites", presented at *34th International SAMPE Symposium and Exhibit*, Reno, NV, May 8-11, 1989.
7. A. K. Roy, "An Overview on Design of Structural Components with Composite Materials", presented as part of a panel on Composites and Laminated Plates and Shells, *AIAA/ASME/ASCEAH/ASC 30th Structures, Structural Dynamics and Materials Conference*, Mobile, AL, April 3-5, 1989.
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11. R. Y. Kim and S. W. Tsai, "An Experimental Study on the Failure of Cross-Ply Ring Under External Pressure", presented at *34th International SAMPE Symposium and Exhibit*, Reno, NV, May 8-11, 1989.
12. S. C. Tan and R. Y. Kim, "Experimental and Theoretical Studies of the Strain and Stress Concentrations of Notched Composite Laminates", presented at 1989 Spring Conference on Experimental Mechanics, Boston, MA, May 28-June 1, 1989.
13. N. J. Pagano and R. Y. Kim, "A Micro-Laminate Effect in Brittle Matrix Composites", presented at *American Society for Composites Symposium on High Temperature Composites*, Dayton, OH, June 13-15, 1989.
14. A. Chatterjee, G. P. Tandon, and L. E. Matson, "Anomalous Expansion Behavior Ceramic Matrix Composites", presented at *American Society for Composites Symposium on High Temperature Composites*, Dayton, OH, June 13-15, 1989.

15. N. J. Pagano, "Failure Modes in Brittle Matrix Composites", presented at *University of Delaware Seminar Series*, April 21, 1989.

16. N. J. Pagano, "Issues in Micromechanical Modeling of BMC", presented at *University of Illinois/ONR Seminar Series*, May 5, 1989.

17. N. J. Pagano and S. R. Soni, "Strength Analysis of Composite Turbine Blades, presented at *American Society for Composites Symposium on High Temperature Composites*, Dayton, OH, June 13-15, 1989.

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2. Niner, P.E., and T.E. Saliba, "Expert Model Control of Advanced Composite Material Processing", Presented at the *AIAA 16th Annual Mini-Symposium*, March 29, 1990. (received best paper award).
3. M.J. Perry, L.J. Lee, and C.W. Lee, "Cure Monitoring of Graphite/Epoxy Composites by Scaling Analysis and Heat Flux Sensors", Presented at the *35th International SAMPE Symposium and Exhibition*, April 2-5, 1990, Anaheim California.
4. Abrams, F. L. "Computer Aided Curing of Composites", Presented at the *Sixth Annual Conference on Materials Technology*, Southern Illinois University at Carbondale, Carbondale, IL, April 10-11, 1990.
5. Saliba, T. E., "Process Models, Expert Systems, and Expert Models in Composite Materials Manufacturing", The Ohio State University, Columbus, OH, April, 1990.
6. C.W. Lee and F.L. Abrams, "Knowledge Base for Expert System Process Control/Optimization", Presented at the *Fifth Japan-US Conference on Composite Materials* June 24-27, 1990, Tokyo, Japan.
7. J. M. Whitney and M. F. Pinnell, "Characterization of Interlaminar Mode II Fracture Using Beam Specimens," to be presented at the *Fourth European Conference on Composite Materials*, Stuttgart, West Germany, September 25-28, 1990.

8. J. M. Whitney, "A Modified Shear Deformation Theory for Laminated Anisotropic Plates," presented at *American Society for Composites Fifth Technical Conference*, East Lansing, MI, June 12-14, 1990.

9. J. M. Whitney, "Reflection on the Development of Test Methods for Advanced Composites," invited keynote presentation at *ASTM Tenth Symposium on Composite Materials: Testing and Design*, San Francisco, CA, April 24-25, 1990.

10. J. M. Whitney, "Stress Analysis of the Double Notch Shear Specimen", presented at the *American Society for Composites Fourth Technical Conference*, Virginia Polytechnic Institute and State University, Blacksburg, VA, October 3-5, 1989.

11. S. Mall and R. Y. Kim, "Damage Initiation and Growth in a Quasi-Isotropic Laminate of Ceramics Matrix Composite", Spring Meeting Soc. Exp. Mech. Albuquerque NM, May 1990.

12. G. P. Tandon and N. J. Pagano "Influence of Partial Interface Debonding on Composite Moduli", 5th Japan-U.S. Conference, Tokyo, Japan, June 1990.

13. R. Schiavone and S. Gunderson, "The Components and Structure of Insect Exoskeleton Compared to Man-Made Advanced Composites", *ASC 4th Annual Technical Conference*, 5 October 1989.

14. S. Gunderson and R. Schiavone, "Potential Applications of Biotechnology to Aerospace Materials and Structures", *AIAA 16th Annual Mini-Symposium*, 28 March 1990.

15. S. Gunderson, R. Narayan and R. Schiavone, "An Overview of Three Biotechnology Areas for the Development of Advanced Composite Materials and Structures", *ASC 5th Annual Technical Conference*, 12 June 1990.

16. A. S. Crasto and D. P. Anderson, "Correlation of Structure and Compressive Strength in Pitch-Based Graphite Fibers", *ASC 5th Annual Technical Conference*, 12-14 June 1990.

17. M. F. Pinnell, M. Knight, and W. B. Pinnell, "A Fractographic and Experimental Analysis of Composite Compression Test Methods", *ASC 5th Annual Technical Conference*, East Lansing, MI, June 12-14, 1990.

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1991

FY-91 PRESENTATIONS

A. Failure in Polymer Matrix Composites

1. A. S. Crasto and R. Y. Kim, "Compression Strengths of Advanced Composites from a Novel Mini-Sandwich Beam," at the *22nd International SAMPE Technical Conference*, Boston, MA, November 1990.
2. A. S. Crasto, R. Y. Kim and J. M. Whitney, "Advanced Laminate Compression Strengths from a Novel Sandwich Test Specimen," at the *32nd AIAA Structures, Dynamics, and Materials Conference*, Baltimore, MD, April 1991.
3. A. S. Crasto and R. Y. Kim, "Nonlinear Stress-Strain Behavior in Advanced Fibers and Composites," at the *36th International SAMPE Symposium*, San Diego, CA, April 1991.
4. R. Y. Kim and A. Miravette, "Effect of Residual Stresses on the Fracture of Thermoplastic Composites," at the *ICCM VIII Conference*, Honolulu, HI, July 1991.
5. A. S. Crasto, R. Y. Kim and J. M. Whitney, "A New Test Method to Determine the Compressive Strength of Fiber-Reinforced Composites," at the *73rd AGARD Workshop*, San Diego, CA, September 1991.
6. A. K. Roy and R. Y. Kim, "Measurements to Determine the Thermal Expansion Coefficient (CTE) of Laminated Orthotropic Rings," at the *6th ASC Technical Conference*, Albany, NY, October 1991.
7. R. Y. Kim, A. S. Crasto and Y. J. Yum, "Analysis of a Novel Compression Test Specimen: A Miniature Sandwich Beam," at the *16th Annual Mechanics of Composites Review*, Dayton, OH, November 1991.
8. J. M. Whitney, "Torsion of Orthotropic Plates", *16th Annual Mechanics of Composites Review*, Dayton, OH, November 12-13, 1991.
9. J. M. Whitney and D. H. Rose, "Effect of Transverse Normal Stress on the Bending of Thick Laminated Plates," *Eighth International Conference on Composite Materials (ICCM VIII)*, Honolulu, HI, July 15-19, 1991.
10. J. M. Whitney, "Stress Analysis of Laminated, Anisotropic Plates Subjected to Torsional Loading", presented at *AIAA/ASME/ASCEAH/ASC 32nd Structures, Structural Dynamics and Materials Conference*, Baltimore, MD, April 8-10, 1991.
11. J. M. Whitney and S. K. Guihard, "Failure Modes in Compression Testing of Composite Materials", presented at *36th International SAMPE Symposium and Exhibit*, San Diego, CA, April 15-18, 1991.
12. J. D. Russell and D. B. Curliss, "Effect of Different Thermal Histories on the Mechanical Properties and Fracture Toughness of APC-2", *23rd International SAMPE Technical Conference*, Kiamesha Lake, NY, October 1991.
13. J. D. Russell, "Physical and Mechanical Properties of Courtaulds' Filmix Fabric", *36th International SAMPE Symposium*, San Diego, CA, April 1991.

B. Failure Modes in Brittle Matrix Composites

1. N. J. Pagano, Axisymmetric Failure Model for Brittle Matrix Composites, presented at the *15th Annual Mechanics of Composites Review*, Oct 24, 1990.
2. R. D. Kurtz and N. J. Pagano, Stress Analysis of Embedded Fibers, presented at the *15th Annual Mechanics of Composites Review*, Oct 25, 1990.
3. N. J. Pagano, Effect of Debonding on the Behavior of Brittle Matrix Composites, presented at the *First Thermal Structures Conference*, Nov 15, 1990, Univ of Virginia.
4. N. J. Pagano, Mechanics of Brittle Matrix Composites, invited seminar at Clemson Univ, Clemson SC, Nov 16, 1990.
5. R. Y. Kim and N. J. Pagano, Failure of Multidirectional Laminates of SiC/CAS Composites Paper presented at the *15th Annual Conference on Composites and Advanced Ceramics*, American Ceramic Society, Cocoa Beach FL, Jan 1991.
6. H. W. Brown, Strain Energy Release Rate of Delamination Using Subliminate Analysis, presented at the *AIAA Dayton-Cincinnati 1991 Mini-Symposium*, Mar 14, 1991.
7. G. P. Tandon and N. J. Pagano, Effective Moduli of Partially Debonded Composites, to be presented at the *16th Annual Mechanics of Composites Review*, Dayton OH, Nov 12-13, 1991.

C. Processing Research

1. C. W. Lee and B. P. Rice, "On-Line Determination of Composite Laminate Thermal Diffusivity and Heat Release Rate", *The 36th International SAMPE Symposium and Exhibition*, April 15-18, 1991, San Diego CA.
2. J. D. Russell, "Analysis of Viscoelastic Properties of High-Temperature Polymers Using a Thermodynamic Equation of State", *M.S. Thesis, University of Dayton*, November 1991.

D. Carbon-Carbon Composites Research

1. S.Y Limaye and J.W. Hager, "Low Thermal Expansion (NZP) Ceramic Materials for Oxidation Protection Coatings", poster presentation at the *NIST Workshop on Carbon-Carbon Materials*, Gaithersburg, December 6-7, 1990.
2. S.S. Sandhu and J. W. Hager, "A Fundamental Approach for the Protection of a Carbon-Carbon Material in a Hostile Environment", poster presentation at the *NIST Workshop on Carbon-Carbon Materials*, Gaithersburg, December 6-7, 1990.
3. M. L. Lake and J. W. Hager, "Vapor-Grown Carbon Fibers as a Test-Bed for Fundamental Studies of Carbon-Carbon Composites", poster presentation at the *NIST Workshop on Carbon-Carbon Materials*, Gaithersburg, December 6-7, 1990.
4. P. G. Wapner and J. W. Hager, "The Surface Tension of Mesophase Pitch", presented at the *15th Conference on Metal Matrix, Carbon, and Ceramic Matrix Composites*, Cocoa Beach, January 16-18, 1991.

5. D. P. Anderson and W. A. Price "A Morphological Investigation of Several Similarly Processed Carbon-Carbon Samples", presented at the *15th Conference on Metal Matrix, Carbon, and Ceramic Matrix Composites*, Cocoa Beach, January 16-18, 1991.
6. A. S. Gurney, D. P. Anderson and A. Crasto "Analysis of T-40R Fiber for Carbon-Carbon Composites", presented at the *15th Conference on Metal Matrix, Carbon, and Ceramic Matrix Composites*, Cocoa Beach, January 16-18, 1991.
7. W.R. Ragland and J. W. Hager, "Impregnation Techniques for Displaying the Microstructure of Porous Structural Materials", poster presentation at the *20th Biennial Conference on Carbon*, Santa Barbara, June 23-28, 1991.
8. P. G. Wapner and J. W. Hager, "The Effect of Additives on the Surface Tension of Mesophase Pitch", presented at the *20th Biennial Conference on Carbon*, Santa Barbara, June 23-28, 1991.
9. S. S. Sandhu and J.W. Hager, " A Mass-Loss Model for a Carbon-Carbon Composite in a Protective Gas Environment", presented at the *Eighth International Conference on Composite Materials (ICCM/VIII)*, Honolulu, July 15-19, 1991.
10. R. Hall, "Effective Moduli of Cellular Materials," presented at the *American Society for Composites 6th Technical Conference on Composite Materials*, Albany NY, October 1991.
11. K. M. Kliner, "A Knowledge Base Approach Relating Composite Defects to Cure Parameters", presented at the *American Society for Composites 6th Technical Conference on Composite Materials*, Albany, NY, 7-9 Oct 91.
12. S. S. Sandhu, A. K. Yui and J. W. Hager, "A Predictive Model for the High-Temperature Carbon-Carbon Structural Material", poster presentation at *AIChE Annual Meeting*, Los Angeles, 18-22 Nov 91.
13. R. Mehta and J. W. Hager, "Highly Graphitic Open-Celled Carbon Foam: Processing and Characterization", poster presentation at *AIChE Annual Meeting*, Los Angeles, 18-22 Nov 91.
14. A. Roy, "Characterization and Issues of Material Modeling of 2-D Carbon-Carbon Composite Laminates", presented at the *16th Annual Mechanics of Composites Review*, Dayton, OH, 12-13 Nov 91.
- E. Biotechnology**
1. J. E. Saliba, R. C. Schiavone, S. L. Gunderson, and D. G. Taylor, "Mechanics of Natural Composites," *1990 MRS Fall Conference*, Boston, MA (November, 1990).
2. J. A. Lute and S. L. Gunderson, "Mechanical Characterization of Preformed vs. Drilled Holes," *AIAA 17th Annual Mini-Symposium on Aerospace Science and Technology*, Dayton, OH (March 1991).
3. J. E. Saliba, S. L. Gunderson, and D. G. Taylor, "Transverse Modulus of Fiber-Reinforced Single Lamina," *AIAA 17th Annual Mini-Symposium on Aerospace Science and Technology*, Dayton, OH (March 1991).

4. J. E. Saliba, S. L. Gunderson, and D. G. Taylor, "Finite Element Micromechanics of Fiber-Reinforced Composite Materials," *AIAA 17th Annual Mini-Symposium on Aerospace Science and Technology*, Dayton, OH (March 1991).
5. S. L. Gunderson and R. C. Schiavone, "Microstructure of An Insect Cuticle and Its Applications to Advanced Composites" and "Biomimetic Applications of Smart Technologies," AFOSR Sponsored Workshop--*Design and Processing of Materials by Biomimicking*, Seattle, WA (April 1991).
6. J. W. Sawvel, E. V. Nelson, S. L. Gunderson, and R. C. Schiavone, "Characteristics of Cuticular Proteins in *Odontotaenius disjunctus*," *Ohio Academy of Sciences*, Columbus, OH, (May 1991).

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1. A. K. Roy, "Strength Analysis and Design of Multilayered Thick Composite Spherical Pressure Vessels," WRDC/TR-90-4141, Wright-Patterson Air Force Base, OH (March 1991).
2. R. Y. Kim and A. Roy, "Measurement of Interlaminar Shear Stiffness of Symmetric Laminates by Three-Point Bend Test," *Experimental Techniques*, 34 (1990).
3. R. Y. Kim and S. C. Tan, "Strain and Stress Concentrations in Composite Laminates Containing a Hole," *Experimental Mechanics* 30 345-351 (1990).
4. R. Y. Kim and A. Crasto, "A Longitudinal Compression Test for Composites Using a Sandwich Specimen," *Journal of Composite Materials* (accepted).
5. J. M. Whitney and D. H. Rose, "Effect of Transverse Normal Stress on the Bending of Thick Laminated Plates," *Proceedings of the Eighth International Conference on Composite Materials (ICCM VIII)*, Edited by S. W. Tsai and G. S. Springer, SAMPE, Covina, CA, 1991, pp. 30-B-1 - 30-B-10.
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8. J. M. Whitney and S. K. Guihard, "Failure Modes in Compression Testing of Composite Materials," *Proceedings of the 36th International SAMPE Symposium and Exhibit*, Vol. 36, Edited by J. Stinson, R. Adsit, and F. Gordanejad, Book 1, 1991, pp. 1069-1073.
9. A. S. Crasto and R. Y. Kim, "Nonlinear Stress-Strain Behavior in Advanced Fibers and Composites," *Proceedings of the 36th International SMAPE Symposium/Exhibition*, 36 (April 1991).

10. A. S. Crasto and R. Y. Kim, "Compression Strengths of Advanced Composites from a Novel Mini-Sandwich Beam", *Proceedings of the 22nd International SAMPE Technical Conference*, 22, Boston, MA (November 1990).

11. R. Y. Kim and A. Miravette, "Effect of Residual Stresses on the Fracture of Thermoplastic Composites," *Proceedings of the 8th International Conference on Composite Materials (ICCM VIII)*, Honolulu, HI, July 1991.

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3. G. P. Tandon and A. Chatterjee, "The Transverse Coefficient of Thermal Expansion of a Unidirectional Composite," *Journal of Materials Science*, Vol 26, 1991, pp. 2759-2764.

4. R. Y. Kim and N. J. Pagano, "Crack Initiation in Unidirectional Brittle Matrix Composites," *Journal of American Ceramic Society*, v74, n5, May 1991.

C. Processing Research

1. Lee, C. W. and Rice, B. P., "On-Line Determination of Composite Laminate Thermal Diffusivity and Heat Release Rate," *Proceedings of the 37th International SAMPE Symposium and Exhibition*, April 15-18, 1991, San Diego, CA.

D. Carbon-Carbon Composites Research

1. S.Y Limaye and J.W. Hager, "Low Thermal Expansion (NZP) Ceramic Materials for Oxidation Protection Coatings", *Proceedings of the NIST Workshop on Carbon-Carbon Materials*, Gaithersburg, 1991.

2. S.S. Sandhu and J. W. Hager, "A Fundamental Approach for the Protection of a Carbon-Carbon Material in a Hostile Environment", *Proceedings of the NIST Workshop on Carbon-Carbon Materials*, Gaithersburg, 1991.

3. M. L. Lake and J. W. Hager, "Vapor-Grown Carbon Fibers as a Test-Bed for Fundamental Studies of Carbon-Carbon Composites", *Proceedings of the NIST Workshop on Carbon-Carbon Materials*, Gaithersburg, 1991.

4. P. G. Wapner and J. W. Hager, "The Surface Tension of Mesophase Pitch", NASA Conference Publication 3133, *Proceedings of the 15th Conference on Metal Matrix, Carbon, and Ceramic Matrix Composites*, Cocoa Beach, 1991, pp. 13-23.
5. W.R. Ragland and J. W. Hager, "Impregnation Techniques for Displaying the Microstructure of Porous Structural Materials", *Extended Abstracts of the 20th Biennial Conference on Carbon*, Santa Barbara, 1991, pp. 348-349.
6. P. G. Wapner and J. W. Hager, "The Effect of Additives on the Surface Tension of Mesophase Pitch", *Extended Abstracts of the 20th Biennial Conference on Carbon*, Santa Barbara, 1991, pp. 188-189.
7. S. S. Sandhu and J.W. Hager, "A Mass-Loss Model for a Carbon-Carbon Composite in a Protective Gas Environment", *Proceedings of the Eighth International Conference on Composite Materials (ICCM/8)*, Honolulu, July 15-19, 1991, SAMPE, pp. 22F-1-10.
8. R. Hall, "Effective Moduli of Cellular Materials," *Proceedings of the American Society for Composites 6th Technical Conference on Composite Materials*, Albany NY, October 1991, Technomic, pp.1080-1089.
9. K. M. Kliner, "A Knowledge Base Approach Relating Composite Defects to Cure Parameters", *Proceedings of the American Society for Composites 6th Technical Conference on Composite Materials*, Albany, NY, 7-9 Oct 91, pp. 1022-1031.
10. A. Roy, "Characterization and Issues of Material Modeling of 2-D Carbon-Carbon Composite Laminates", *Proceedings of the 16th Annual Mechanics of Composites Review*, Dayton, OH, 12-13 Nov 91, pp. 93-97.
11. R. Hall, "Matrix-Dominated Thermoviscoplasticity in Fibrous Metal-Matrix Composite Materials," in *Mechanics of Composites at Elevated and Cryogenic Temperatures*, AMD-Vol. 118, ASME, pp. 39-54, 1991.

E. Biotechnology

1. S. L. Gunderson and R. C. Schiavone, "Structural Composites, Natural," *International Encyclopedia of Composites: Vol. 5* (S. Lee, ed.), VCH Publishers, New York, pp 324-337, July 1991.
2. J. E. Saliba, R. C. Schiavone, S. L. Gunderson, and D. G. Taylor, "Mechanics of Natural Composites," *Materials Research Society Symposium Proceedings: Vol. 218* (M. Alper, et. al eds.), Materials Research Society, Pittsburgh, pp 215-220, 1991.
3. S. L. Gunderson and R. C. Schiavone, "Microstructure of An Insect Cuticle and Its Applications to Advanced Composites" and "Biomimetic Applications of Smart Technologies," in *Proceedings of AFOSR Workshop on Biomimetics*, (in press).

INVENTIONS

1. J. W. Hager, "Graphitic Ligament Reticulated Carbon Foams From Mesophase Pitch Precursors", submitted September 1990; patent search in 1991 revealed competing patent from 1981 by a French group.

2. J. W. Hager and S. S. Sandhu, "Synthetic Gas Protection System for Carbon Structural Materials in Oxidizing Environments", submitted September 1990; patent search in 1991 revealed no competing patents; patenting by Air Force underway.

1992

FY-92 PRESENTATIONS

A. Failure in Polymer Matrix Composites

1. A. K. Roy, "Characterization and Issues of Material Modeling of Two-Dimensional Carbon-Carbon Composite Laminates," 16th Mechanics of Composites Review, Dayton, OH (November 1991).
2. A. K. Roy and S. W. Tsai, "Three-Dimensional Effective Moduli of Orthotropic and Symmetric Laminates," 112th ASME Winter Annual Meeting, Atlanta, GA (December 1991).
3. R. Y. Kim and A. S. Crasto, "Longitudinal Compression Strength of Glass Fiber-Reinforced Composites," 47th Annual SPI Conference, Cincinnati, OH (February 1992).
4. Satish Kumar, V. Mehta, D. P. Anderson, and A. S. Crasto, "Compressive Strength of Carbon Fibers," 37th International SAMPE Symposium, Anaheim, CA (March 1992).
5. A. K. Roy and G. Verchery, "A Comparative Study of Interlaminar Shear Stiffness of Symmetric Laminated Beams Predicted by Various Methods, 37th International SAMPE Symposium, Anaheim, CA (March 1992).
6. J. M. Whitney and R. Y. Kim, "Use of the Double Notch Shear Specimen for Characterizing Interlaminar Failure of Composite Materials," 33rd AIAA Structures, Structural Dynamics and Materials Conference, Dallas, TX (April 1992).
7. W. Pinnell, A. S. Crasto, and R. Y. Kim, "Failure Analysis of Composites Loaded in Compression," Second ASTM Symposium on Fractography of Modern Engineering Materials, Pittsburgh, PA (May 1992).
8. A. S. Crasto and R. Y. Kim, "The Influence of Constituent Properties on Composite Compression Strength," 5th U.S.-Japan Conference on Composite Materials, Orlando, FL (June 1992).
9. A. K. Roy, "In-Plane Static and Fatigue Properties of Two-Dimensional Carbon-Carbon," NASP TPS Meeting, West Palm Beach, FL (June 1992).
10. A. S. Crasto and R. Y. Kim, "Analysis of a Novel Compression Test Specimen: A Miniature Sandwich Beam," ECCM-CTS, Amsterdam, The Netherlands (September 1992).
11. A. K. Roy, "Static and Fatigue Properties of Coated 2D Carbon-Carbon," IDA Carbon-Carbon Technical Exchange Conference, Virginia (September 1992).
12. J. M. Whitney, A. S. Crasto and R. Y. Kim, "Failure Criteria for Laminated Composites Subjected to Compression Loading," 7th ASC Annual Technical Conference (October 1992).
13. A. S. Crasto and R. Y. Kim, "On the Determination of Residual Stresses in Fiber-Reinforced Thermoset Composites," 7th ASC Annual Technical Conference (October 1992).

14. D. H. Rose and J. M. Whitney, "Effect of Prestressing on Laminated Plates," 17th Annual Mechanics of Composites Review, Dayton, OH (October 1992).

B. Failure Modes in Brittle Matrix Composites

1. N. J. Pagano and R. Y. Kim, "Observation of Full-Cell Cracking in Brittle Matrix Composites," Third International Ceramic Science and Technology Congress & Exposition. San Francisco, Nov 1-4, 1992.
2. H. W. Brown III, "Analysis of Axisymmetric Micromechanical Concentric Cylinder Model," Mechanics of Composites Review, Dayton, OH, Oct 27-28, 1992.
3. N. J. Pagano, "Axisymmetric Micromechanical Stress Fields in Composites, IUTAM Symposium, Blacksburg, VA, Oct 28-31, 1992 (Opening Presentation).
4. N. J. Pagano, "The Full-Cell Cracking Mode in Unidirectional Brittle Matrix Composites," Fatigue and Fracture of Inorganic Composites, Mar 31 - Apr 2, 1992, Churchill College, Cambridge, UK (Keynote talk).
5. N. J. Pagano, "Failure Modes in Unidirectional Brittle Matrix Composites"

Caen University, Caen, France, Apr 6, 1992
ONERA, Paris, France, Apr 8, 1992
University of Lyon, Lyon, France, Apr 10, 1992.

6. N. J. Pagano, "Micromechanical Fracture Mechanisms in Unidirectional Ceramic Matrix Composites"

Cal Tech University, Nov 10, 1992
University of California at San Diego, Nov 11, 1992
UCLA, Nov 12, 1992
University of California at Santa Barbara, Nov 13, 1992
Rennselair Polytechnic Institute, Dec 2, 1992

C. Processing Research

1. J. R. McCoy, "The Chemical Composition, Analysis, and Reactivity of AFR700 Resin," *High Temple Workshop XII*, 27-30 January 1992, Cocoa Beach FL.
2. B. Rice and B. Price, "Postcure Considerations for AFR700B," *High Temple Workshop XII*, 27-30 January 1992, Cocoa Beach FL.
3. D. B. Curliss and J. D. Russell, "The Effect of Thermal History and Environmental Conditioning on the Creep of APC-2," *Ninth Thermoplastic Matrix Composites Review*, San Diego CA, February 1992
4. T. Saliba, P. Smolinski, and D Hofmann, "In-Situ Cure Monitoring of Advanced Composite Materials," *37th International SAMPE Symposium and Exhibition*, 12 March 1992, Anaheim CA.
5. D. B. Curliss and J. D. Russell, "Characterization of Aerospace Resins and Composites Using Pressurized Volumetric Dilatometry," *37th International SAMPE Symposium and Exhibition*, 12 March 1992, Anaheim CA.

6. K. Trick, "Modeling Diffusion in Two-Dimensional Complex Shaped Systems," *37th International SAMPE Symposium and Exhibition*, 12 March 1992, Anaheim CA.
7. B. Rice, "Towards Thick Panel Processing of AFR700B Composites," *AFR700B Symposium/Workshop*, 17-18 September 1992, Fairborn OH.
8. B. Rice, "Extended Autoclave Cure Cycle - An Alternative to Oven Postcure," *AFR700B Symposium/Workshop*, 17-18 September 1992, Fairborn OH.

D. Carbon-Carbon Composites Research

1. S. Kumar, V. Mehta, D. P. Anderson, and A. S. Crasto, "Compressive Strength of Carbon Fibers," paper presented at the 37th International SAMPE Symp. (March 1992).
2. D. P. Anderson and K. E. Gunnison, and J. W. Hager, "Ligament Structure of Open-Cell Carbon Foams and the Construction of Models Based on that Structure," poster paper presented at the MRS meeting, San Francisco, CA (April 1992).
3. D. P. Anderson, P. G. Wapner, and D. B. Curliss, "Physical Property Characteristics of Pitch Materials," poster paper presented at the MRS meeting, San Francisco, CA (April 1992).
4. S. S. Sandhu, A. K. Yui and J. S. Sandhu, "Reduction of Oxygen Transport to the Interior Surface of a Carbon-Carbon Tube," poster presentation at the AIChE Annual Meeting, Miami Beach, FL (November 1992).
5. J. W. Hager, "Novel Composite Structures Based on Graphitic Carbon Foams," SAMPE Local Chapter Meeting, Dayton, OH (September 1992).
6. J. W. Hager, "Novel Composite Structures Based on Graphitic Carbon Foams," presented at the IDA Carbon-Carbon Technical Exchange Conference, Arlington, VA (September, 1992).
7. A.K. Roy, "A Self-Aligned Test Fixture for Interlaminar Tensile Testing of Two-Dimensional Carbon-Carbon," presented at the 17th Mechanics of Composites Review, Dayton, OH (October, 1992).
8. A.K. Roy, "Static and Fatigue Properties of Coated 2D Carbon-Carbon," presented at the IDA Carbon-Carbon Technical Exchange Conference, Arlington, VA, (September, 1992).
9. A.K. Roy, "In-Plane Static and Fatigue Properties of Two-Dimensional Carbon-Carbon," presented at the NASP TPS Meeting, West Palm Beach, Florida, 23-24 June 1992.
10. R. Hall, "Mechanical Modeling of Structural Foams," presented at AIAA Minisymposium, Dayton, Ohio, 26 March 1992.

E. Biotechnology

1. K. E. Gunnison-Thorp and S. L. Gunderson, "The Insect Cuticle and Its Applications to Ceramic-Matrix Composites", American Ceramic Society, 45th Pacific Coast Regional Meeting, San Francisco, CA , November, 1992.

2. S. L. Gunderson and K. E. Gunnison, "Biotechnical Materials", Wright-Step Program, Dayton, OH, July, 1992.

3. A. Schell, "Granola Technologies in Defense: 'Back to Nature' Math, Science and Technology," keynote address including preformed hole data/viewgraphs supplied by biomimetics group to illustrate the applicability of features incorporated in natural systems to future aerospace technology. Government Neural Network Applications Workshop (GNN 92), WPAFB, OH, August 1992.

FY-92 PUBLICATIONS

A. Failure in Polymer Matrix Composites

Peer Reviewed

1. A. K. Roy, "Response of Thick Laminated Composite Rings Due to Thermal Stresses," *Composite Structures*, 18, 125-138 (1991).

2. S. C. Tan and R. Y. Kim, "Damage Accumulation and Fracture of Notched Composite Laminates Under Tensile and Compressive Loading," ASTM STP 1120, 414-427 (January 1992).

3. A. K. Roy and S. W. Tsai, "Three-Dimensional Effective Moduli of Orthotropic and Symmetric Laminates," Journal of Applied Mechanics, Trans. of ASME, 59(1), 39-47 (March 1992).

4. A. K. Roy, "An Analytical Method for Predicting In-Plane and Interlaminar Thermal Expansion Coefficients of Laminated Orthotropic Rings," *Composites Science and Technology*, 45(2), 111-116 (1992).

5. A. K. Roy and T. N. Massard, "Strength Analysis and a Design Study of Thick Multilayered Composite Spherical Pressure Vessel," *Journal of Reinforced Plastics and Composites*, 11, 479-493 (May 1992).

Non Peer Reviewed

1. A. S. Crasto, R. Y. Kim, and J. M. Whitney, "A New Test Method to Determine the Compressive Strength of Fiber-Reinforced Composites," *Proceedings for AGARD Conference*, 73, 3-1 (October 1991).

2. R. Y. Kim and A. S. Crasto, "Longitudinal Compression Strength of Glass Fiber-Reinforced Composites," *Proceedings of Annual SPI Conference*, 47 (February 1992).

3. A. K. Roy and G. Verchery, "A Comparative Study of Interlaminar Shear Stiffness of Symmetric Laminated Beams Predicted by Various Methods," *Proceedings of International SAMPE Symposium*, 37 (March 1992).

4. S. Kumar, V. Mehta, D. P. Anderson, and A. S. Crasto, "Compressive Strength of Carbon Fibers," *International SAMPE Symposium*, 37, 967 (1992).

5. J. M. Whitney and R. Y. Kim, "Use of the Double Notch Shear Specimen for Characterizing Interlaminar Failure of Composite Materials," *Proceedings of 33rd AIAA Structures, Structural Dynamics and Materials Conference, Part 5, AIAA*, Washington, DC, 2924-2931 (1992).

6. A. S. Crasto and R. Y. Kim, "Analysis of a Novel Compression Test Specimen: A Miniature Sandwich Beam," *Composites Testing and Standardisation*, ECCM-CTS, Amsterdam, The Netherlands (September 1992).
7. J. M. Whitney, A. S. Crasto and R. Y. Kim, "Failure Criteria for Laminated Composites Subjected to Compression Loading," *Proceedings of 7th ASC Annual Technical Conference* (October 1992).
8. A. S. Crasto and R. Y. Kim, "On the Determination of Residual Stresses in Fiber-Reinforced Thermoset Composites," *Proceedings of 7th ASC Annual Technical Conference* (October 1992).
9. D. H. Rose and J. M. Whitney, "Effect of Prestressing on Laminated Plates," *Proceedings of the 17th Annual Mechanics of Composites Review* (October 1992).

B. Failure Modes in Brittle Matrix Composites

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1. S. Mall, W. E. Fink III, and R. Y. Kim, "Mechanical Behavior of a Fiber Reinforced Ceramic Composite Under Off-Axis Loading." *Adv. Composite Mater.*, Vol. 2, No. 1, pp 69-83 (1992).
2. N. J. Pagano and H. W. Brown III, "The Full-Cell Cracking Mode in Unidirectional Brittle Matrix Composites," accepted for publication, *Composites*, Feb. 1993.
3. A. K. Kaw and N. J. Pagano, "Axisymmetric Thermoelastic Response of a Composite Cylinder Containing an Annular Matrix Crack," accepted for publication, *J. Composite Materials*.

Non Peer Reviewed

1. R. Y. Kim, "Experimental Observation of Progressive Damage in SiC/Glass-Ceramic Composites," *Ceramic and Engineering & Science Proceedings*, Vol. 13, No. 7-8, 1992, American Ceramic Society.
2. R. Y. Kim, "Failure of Multidirectional SiC/Glass-Ceramic Laminates," American Society of Composites 7th Technical Conference on Composite Materials, the Pennsylvania State University, University Park, PA, October 13-15, 1992.
3. G. P. Tandon and N. J. Pagano, "Effective Moduli of Partially Debonded Composites," *Mechanics of Composites Review*, Dayton, OH, Nov 12-13, 1991, pp 98-107.
4. G. P. Tandon, and N. J. Pagano, "Modeling of Interfacial Debonding in Brittle Matrix Composites," American Society for Composites 7th Technical Conference, The Pennsylvania State University, University Park, PA, Oct 13-15 1992.
5. N. J. Pagano, "Some Fracture Problems in Unidirectional Brittle Matrix Composites," *Mechanics of Composites Review*, Dayton, OH, Oct 27-28, 1992.

6. N. J. Pagano, "Axisymmetric Micromechanical Stress Fields in Composites," in Local Mechanics Concepts for Composite Material Systems, J. N. Reddy and K. L. Reifsnider eds., Springer-Verlag, page 1, 1991 International Union of Theoretical and Applied Mechanics, Blacksburg, VA, 1991.

C. Processing Research

Peer Reviewed

1. T. E. Saliba, S. R. Quinter, and F. L. Abrams, "Expert Model for Intelligent Control of Composite Materials Processing in a Press," *International Journal of Composites Engineering*, November 1991.

Non Peer Reviewed

1. K. Kliner, "A Knowledge Base Approach Relating Composite Defects to Process Conditions," *American Society for Composites, Sixth Technical Conference*, 7-9 October 1992, Albany NY.

2. K. Kliner, "Carbon-Carbon Composites: Cure of Precursory Carbon Fabric/Phenolic Composites," *WL-TR-92-4008*, March 1992.

D. Carbon-Carbon Composites Research

Peer Reviewed

1. C. J. Wolf, J. A. Bornmann, M. A. Grayson, and D. P. Anderson, "Thermal and Fluid-Induced Crystallinity in Poly(Aryl-Ether-Ether-Ketone) (PEEK)," *J. Polymer Science: Part B: Polymer Physics*, 30, 251 (1992).

2. Satish Kumar, D. P. Anderson, and A. S. Crasto, "Carbon Fiber Compressive Strength and Its Dependence on Structure and Morphology," *J. Material Science*, (accepted April 1992).

3. D. P. Anderson and K. E. Gunnison, and J. W. Hager, "Ligament Structure of Open-Cell Carbon Foams and the Construction of Models Based on that Structure," in *Novel Forms of Carbon*, C. L. Renschler, J. J. Pouch, and D. M. Cox, editors; Mater. Res. Soc. Symp. Proc., 270 (1992) 47.

4. D. P. Anderson, P. G. Wapner, and D. B. Curliss, "Physical Property Characteristics of Pitch Materials," in *Novel Forms of Carbon*, C. L. Renschler, J. J. Pouch, and D. M. Cox, editors; Mater. Res. Soc. Symp. Proc., 270 (1992) 59.

5. J. W. Hager, "Idealized Strut Geometries for Open-Celled Foams," in *Novel Forms of Carbon*, C. L. Renschler, J. J. Pouch, and D. M. Cox, editors; Mater. Res. Soc. Symp. Proc., 270 (1992) 41.

6. J. W. Hager and M. L. Lake, "Novel Hybrid Composites Based on Carbon Foams," in *Novel Forms of Carbon*, C. L. Renschler, J. J. Pouch, and D. M. Cox, editors; Mater. Res. Soc. Symp. Proc., 270 (1992) 29

7. S. S. Sandhu and J. W. Hager, "Formulation of a Mathematical Process Model for the Foaming of a Mesophase Carbon Precursor," in *Novel Forms of Carbon*, C. L.

Renschler, J. J. Pouch, and D. M. Cox, editors; Mater. Res. Soc. Symp. Proc., 270 (1992) 35.

8. K. Kliner, "Pressure Effects on Phenolic/Carbon Composite Autoclave Cure," M.S. Thesis, University of Dayton (December 1992).

9. A.K. Roy and S.W.Tsai, "Three-dimensional Effective Moduli of Orthotropic and Symmetric Laminates," Journal of Applied Mechanics, Trans. of ASME, March 1992, Vol 59, No 1, pp 39-47.

10. A.K. Roy, "An Analytical Method for Predicting In-Plane and Interlaminar Thermal Expansion Coefficients of Laminated Orthotropic Rings," Composites Science and Technology, Vol 45, No 2, 1992, pp 111-116.

11. A.K. Roy and T.N. Massard, "Strength Analysis and A Design Study of Thick Multilayered Composite Spherical Pressure Vessel," Journal of Reinforced Plastics and Composites, Vol 11, May 1992, pp 479-493.

12. A.K. Roy and G. Verchery, "Approximate Methods for Predicting Interlaminar Shear Stiffness of Laminated and Sandwich Beams," to appear in SAMPE Quarterly.

13. A.K. Roy and R.Y. Kim, "An Experimental Technique for Measuring Interlaminar Tensile Stiffness and Strength of Composite Laminates: An Experimental Study," to appear in the Journal of Reinforced Plastics and Composites.

14. A.K. Roy and R.Y. Kim, "Measurements for Determining the Thermal Expansion Coefficients (CTE) of Laminated Orthotropic Rings," to appear in the Journal of Reinforced Plastics and Composites.

Non Peer Reviewed

1. A. Crasto, et al., "Improved Technology for Advanced Composite Materials," WL-TR-91-4143 Volume IV, US Air Force Technical Report (February 1992) edited by D. P. Anderson.

2. S. Kumar, V. Mehta, D. P. Anderson, and A. S. Crasto, "Compressive Strength of Carbon Fibers," Proc. 37th International SAMPE Symp. (March 1992).

3. W. R. Ragland, "Evaluation of Characterization Techniques for Carbon-Carbon Composites," WL-TR-92-4027, US Air Force Technical Report (May 1992).

E. Biotechnology

Peer Reviewed

1. S. L. Gunderson, K. E. Gunnison, and J. W. Sawvel, "Hierarchical Structure of a Natural Composite: Insect Cuticle", accepted for publication, Materials Research Society Proceedings.

2. S. L. Gunderson and J. M. Whitney, "Insect Cuticle Microstructure and Its Applications to Advanced Composites", accepted for publication, J. of Biomimetics.

3. R. Hall, "Effective Moduli of Cellular Materials," accepted for publication, Journal of Reinforced Plastics and Composites.

Non Peer Reviewed

1. S. L. Gunderson and J. A. Lute, "The Use of Preformed Holes for Increased Strength and Damage Tolerance of Advanced Composites", Proceedings of the American Society for Composites, Seventh Technical Conference, Technomic Publishing Co., Inc., October 1992.
2. R. Hall, "Mechanical Modeling of Structural Foams," AIAA Mini-Symposium on Aerospace Science and Technology, Dayton, OH, March 1992.
3. S. L. Gunderson and J. M. Whitney, "Analysis of a Composite Laminate Having a Novel Unsymmetric Ply Orientation", Proceedings of the American Society for Composites, Sixth Technical Conference, Technomic Publishing Co., Inc., pp 309-318, October, 1991.

INVENTIONS

1. D. H. Rose, AF Invention Number 20695: Prestressing Composite Materials for Improved Performance and Fiber Linearity, awarded 18 Aug 92.
2. J. W. Hager and S.S. Sandhu, "Synthetic Gas Protection System for Carbon Structural Materials in Oxidizing Environments", submitted September 1990; patent search in 1991 revealed no competing patents; patent application by Air Force underway.

1993

No information is available for 1993.

1994

No information is available for 1994.

1995

FY95 PUBLICATIONS AND PRESENTATIONS

"Environmental Effects on Polymer Matrix Composites"

Unreviewed Publication:

Thorp, K. E. G. and Crasto, A. S., "Hygrothermal Stability of Polyimide Resins and Composites," in Proceedings of the American Society for Composites - Tenth Technical Conference 1995, pp. 601-613. (1995)

Submitted for Publication:

Curliss, D.B., B.A. Cowans and J.M. Caruthers, "¹⁵N Solid State Study of the Cure Mechanism of a MPBM:MDA Copolymer" (submitted to Macromolecules)

Presentations:

Crasto, A.S. and K.E.G. Thorp "Instability of Polyimide Resins and Composites Subjected to Cyclic Hygrothermal Exposures," TTCP Subgroup P - Materials Technology Technical Panel 6 - Organic Materials, Workshop on High Temperature Resins and Composites, Williamsburg, VA, 1995.

Curliss, D.B. and J.M. Caruthers, "¹⁵N NMR Spectroscopic Investigations of the Curing and Hydrolytic Degradation Reactions in Imide Polymers," AIChE Annual Meeting, San Francisco, CA, 1994.

Curliss, D.B. "Solid State Nuclear Magnetic Resonance Spectroscopic Investigation of the Lifetime Performance of High-Performance Polymers," TTCP Subgroup P - Materials Technology Technical Panel 6 - Organic Materials, Workshop on High Temperature Resins and Composites, Williamsburg, VA, 1995.

Price, W.A., B.P.Rice, A.S. Crasto, K.E.G. Thorp, K.M. Johnson, and D. Cornelia, "Hygrothermal Aging of Imide Composites," Proc. of High Temple Workshop XV, 1995.

Rice, B.P. and W.A. Price, "Processing and Properties of AFR700B - An Update," Proc. of the High Temple Workshop XV, 1995.

1996

FY96 PUBLICATIONS AND PRESENTATIONS

“Environmental Effects on Polymer Matrix Composites”

Unreviewed Publications:

Curliss, D.B., “Solid-State NMR Investigation of Processing and Environmental Durability of High-Temperature Polyimides,” Proceedings of 28th ACS Central Regional Meeting, Composites Technology Symposium, Dayton, OH, 1996.

Reviewed Publications:

Colucci, D.M., G.B. McKenna, A. Lee, D.B. Curliss, K. Bowman, J.D. Russell, “Isochoric and Isobaric Glass Formation: Similarities and Differences,” *J. Poly. Sci.: Poly. Phys. Ed.*

Thorp, K.E.G., and A.S. Crasto, “Hygrothermal Stability of Polyimide Resins and Composites”, submitted to *Journal of Thermoplastic Composite Materials*.

Presentations:

Curliss, D.B., “Solid-State NMR Investigation of Processing and Environmental Durability of High-Temperature Polyimides,” 28th ACS Central Regional Meeting, Dayton, OH, 1996.

Curliss, D.B., “Environmental Effects on High Performance Polymers and Composites,” High Temple Workshop XVI, Perdido Beach, 1996.

Rice, B.P., “Recent Studies Concerning Hydrolytic Degradation of High Temperature Polyimides,” High Temple Workshop XVI, Perdido Beach, 1996.

Thorp, K.E.G., and A.S. Crasto, “Hygrothermal Cycling of AFR700B” High Temple Workshop XVI, Perdido Beach, 1996.

1997

FY97 PUBLICATIONS AND PRESENTATIONS

"Environmental Effects on Polymer Matrix Composites"

Published in Peer Reviewed Journals and Books:

Dina M. Colucci, G.B. McKenna, A. Lee, D.B. Curliss, K. Bowman, J.D. Russell, "Isochoric and Isobaric Glass Formation: Similarities and Differences," *J. Poly. Science: Part B, Poly. Phys.*, 35: 1561-1573, 1997.

Published in Unreviewed Publications:

David B. Curliss, "Hygrothermal Studies on Fluorinated Polyimides - Model Compound Studies of Degradation," *Proceedings of the 28th International SAMPE Technical Conference*, Seattle WA, 1996.

E. Eugene Shin, Roger J. Morgan, Jiming Zhou, Jason Lincoln, Robert Jurek, and David B. Curliss, "Hygrothermal Durability and Thermal Aging Behavior Prediction of High Temperature Polymer Matrix Composites and Their Resins," *Proc. of 12th Annual Technical Conference of the American Society for Composites*, Detroit, MI, 1997.

David B. Curliss, "Solid State NMR Investigation of Processing and Environmental Durability of High-Temperature Polyimides," *Proceedings of the 28th ACS Central Regional Meeting*, Dayton OH, 1996.

Rice, B.P., "Hygrothermal Studies on Fluorinated Polyimides - A Physical Characterization," *28th International SAMPE Technical Conference*, November 1996, pp.778-789.

Rice, B.P., "Characterization of High Temperature Polyimides," *Proceedings of High-Temple Workshop XVII*, J1-J23, February 1997.

Rice, B. P., "Characterization of High Temperature Polyimides," *Proceedings of HITEMP Workshop*, Paper 8, pp. 1-13, April 1997.

Rice, B. P. and Lee, C.W., "Study of Blister Initiation and Growth in a High-Temperature Polyimide," *Proceedings of 29th International SAMPE Technical Conference*, October 1997.

Thorp, K. E. G., A. K. Roy, & A. S. Crasto. (1996). The Effect of Isothermal Aging on the Relaxation Spectra of AFR700B. *28th International SAMPE Technical Conference*. (pp. 797-806).

Thorp, K. E. G., & A. S. Crasto. (1997). The Effect of Aging Environment on the Structure and Properties of AFR700B. *Proceedings of the High Temple Workshop XVII* (pp. K1-K31).

“Composite Materials and Structures for Advanced Mobility Concepts”

Publications:

This project was initiated in FY97; hence, no publications have resulted from the work during this FY.

Presentations:

An abstract regarding the progressive failure of Blackglas under acoustic fatigue conditions has been submitted to the AIAA Annual Meeting for presentation in Spring 1998

A paper regarding the failure modes in Blackglas under acoustic fatigue will be submitted to the Annual Meeting of the American Society of Composites in July 1998

A. K. Roy, D. Pullman, and K. Kearns, Experimental Methods for Measuring Tensile and Shear Stiffness and Strengths of Graphitic Foam, to be presented at the 43th Intl. SAMPE Symposium and Exhibition, Anaheim, CA, May 31-June 4, 1998.

A. K. Roy, A Three-dimensional Mixed Variational Model for Graphitic Foam, to be presented at the ASME IMECE, Anaheim, CA, Nov. 15-20, 1998.

Heather J. Anderson, Kristen M. Kearns, and David P. Anderson, “Microcellular Graphitic Foams”, 23rd Biennial Conference on Carbon, July 1997.

Kristen M. Kearns, and David P. Anderson, “Microcellular Graphitic Foam Processing”, 11th International Conference on Composite Materials, July 1997.

David P. Anderson, Kristen M. Kearns, Cindy Tucci, and Gerry Mestemaker, “The Cellular Structure of Net Shaped Pitch-Based Microcellular Carbon-Foams”, 43rd International SAMPE Symposium and Exhibition, 1998.

Heather J. Anderson, Kristen M. Kearns, and David P. Anderson, “Microcellular Pitch-based Carbon Foam Blown with Helium Gas”, 43rd International SAMPE Symposium and Exhibition, 1998.

“New World Vistas: Ballistic Damage Tolerant Composite Materials for UCAV Structural Applications”

Publications:

This project was initiated in FY97; hence, no publications have resulted from the work during this FY.

1998

FY98 PUBLICATIONS AND PRESENTATIONS

“Environmental Effects on Polymer Matrix Composites”

Published in Reviewed Publications:

Curliss, D. B. , J. M. Caruthers, and B. A. Cowans, “Cure Reaction Pathways of Bismaleimide Polymers: A Solid-State ^{15}N NMR Investigation,” *Macromolecules*, 31, 20, p. 6776.

Published in Unreviewed Publications:

Curliss, D. B. and B. A. Cowans, “ ^{15}N Solid State NMR Investigation of Norbornene-terminated Addition Polyimide Cure and Hydrolysis Reactions,” *Proceedings of the Rocky Mountain Analytical Conference*, Denver, 1998.

Katie E. G. Thorp and Allan S. Crasto, “Accelerated Hygrothermal Aging of Polyimides in Saturated Steam at Elevated Pressure,” *High Temple Workshop XVIII Proceedings* (1998).

Allan S. Crasto and Ran Y. Kim, “Hygrothermal Degradation of Polyimides and Its Influence on Mechanical Properties,” *High Temple Workshop XVIII Proceedings* (1998).

Professional Activities:

Katie Thorp, First Vice Chair SAMPE Midwest Chapter

“New World Vistas: Ballistic Damage Tolerant Composite Materials for UCAV Structural Applications”

Unreviewed Publications:

J.M. Brown, D.B. Curliss, R.A. Vaia, “Nanoparticle Toughening of Epoxies,” *ACS Macromolecular Proceedings*, August 1998.

J.M. Brown, D.B. Curliss, R.A. Vaia, “Intrinsically Survivable Composites Using a Nanocomposite Approach,” *Contributed Research & Development*, Vol. 128, Systran Corp. 1998.

1999

FY99 PUBLICATIONS AND PRESENTATIONS

“Environmental Effects on Polymer Matrix Composites”

Published in Reviewed Publications:

Curliss, D. B. and B. A. Cowans, “Cure and Post-Cure Reaction Pathways of Norbornene/Amine-Terminated Addition Polyimides: A Solid-State ^{15}N NMR Investigation,” submitted to Macromolecules.

Professional Activities:

Katie Thorp, First Vice Chair SAMPE Midwest Chapter

“New World Vistas: Ballistic Damage Tolerant Composite Materials for UCAV Structural Applications”

Unreviewed Publications:

Anderson, D. P., & T. Benson Tolle “Composite Property Enhancement with Nanoscale Inorganic Fillers,” PMSE Preprints 82.

Curliss, D. B. “Characterization of a Series of Glassy Epoxy-Silicate Nanocomposites,” PMSE Preprints 82.

Invention Disclosures:

Curliss, D. B. “Functionally Modified Organophilic Mica-Type Silicate for BMI and PI Nanocomposites,” U.S. Patent Application, Sep 99.

Curliss, D. B. “Surface Growth poly-aspartimide for Delamination and Dispersion Stabilization of Organo Mica-Type Silicates,” U.S. Patent Application, Sep 99.

2000

FY00 PUBLICATIONS AND PRESENTATIONS

“Environmental Effects on Polymer Matrix Composites”

Published in Unreviewed Publications:

Curliss, D. B. and Brett A. Cowans, “Processing Dependence of Cure and Post-Cure Reactions in Norbornene Terminated Addition Polyimides,” High Temple Workshop XX, San Diego, 2000.

Thorp, K. E. G., David B. Curliss, and William A. Price, “Model Compound Studies of the Hydrolytic Degradation of Norbornene-Terminated Addition Polyimides,” High Temple Workshop XX, San Diego, 2000.

Price, W. A. and David B. Curliss, “Environmental Durability of High Temperature Polymer Matrix Composites,” High Temple Workshop XX, San Diego, 2000.

Rice, B. P. and C. William Lee, “Study of Blister Initiation and Growth in High Temperature Organic Matrix Composites,” High Temple Workshop XX, San Diego, 2000.

PhD Dissertation:

Thorp, K.E. G., “Hydrolytic Degradation of Norbornene-Terminated Addition Polyimides: A Mechanistic and Kinetic Study,” University of Dayton Ph.D. Dissertation, December, 2000.

Professional Activities:

Katie Thorp, First Vice Chair SAMPE Midwest Chapter

“New World Vistas: Ballistic Damage Tolerant Composite Materials for UCAV Structural Applications”

Non-Refereed Publications:

Curliss, D. B. (2000). Characterization of a Series of Glassy Epoxy-Silicate Nanocomposites ACS Polymer Preprints, **41**, No. 1, 523.

Anderson, D. P., T. Benson Tolle, & T. Gibson. Composite Property Enhancement with Nanoscale Inorganic Fillers, Proc. of ACS PMSE, **82**, 220.

Presentations:

Anderson, D. P., T. Gibson, & T. Benson Tolle (2000). The Effects of Nanoscale Inorganic Fillers on an Aerospace Epoxy Resin, Presentation to the AIAA 25th Dayton-Cincinnati Aerospace Science Symposium. 30 March 2000.

Chen, C. and D. B. Curliss. (2000) Preparation, Characterization and Properties of the Aerospace Epoxy Layered-Silicate Nanocomposite, Presentation to the First Georgia Tech Conference on Nanoscience and Nanotechnology, Atlanta, Georgia, 16 October 2000.

Chenggang Chen, Dave P. Anderson and David Curliss, Processing and Properties of a Series of Epoxy-Silicate Nanocomposites, 219th American Chemical Society National Spring Meeting, San Francisco, California, USA, March 26, 2000.

Anderson, D. P., T. Benson Tolle, & T. Gibson. Composite Property Enhancement with Nanoscale Inorganic Fillers, 219th American Chemical Society National Spring Meeting, San Francisco, California, USA, March 26, 2000.

Submitted/Accepted Presentations and Publications:

Chen, C. and D. B. Curliss "Organoclay-Epoxy Nanocomposites for Aerospace Structural Applications", 221st American Chemical Society National Spring Meeting, San Diego, California, USA, April 1-4, 2001.

Chen C. and D. B. Curliss "Organo-clay Aerospace Epoxy Nanocomposites" SAMPE, Long Beach, CA, May 6-10, 2001.

Rice B. P., C. Chen, L. Cloos, D. Curliss "Carbon Fiber Composites Prepared From Organoclay-Aerospace Epoxy Nanocomposites" SAMPE, Long Beach, CA, USA, May 6-10, 2001.

Refereed Articles (FY00-FY01)

1. Buryachenko, V.A., "Internal Residual Stresses in Elastically Homogeneous Solids: I. Statistically Homogeneous Stress Fluctuations," Int. J. Solids Struct., 37, pp. 4185-4210, 2000.
2. Buryachenko, V.A., "Internal Residual Stresses in Elastically Homogeneous Solids: II. Stress Fluctuations Near a Crack Tip and Effective Energy Release Rate," Int. J. Solids Struct., 37, pp. 4211-4238, 2000.
3. Buryachenko, V.A., "Locality Principle and General Integral Equations of Micromechanics of Composite Materials," Math. Mech. of Solids, 6, pp. 299-321, 2001.
4. Buryachenko, V.A., "Multiparticle Effective Field and Related Methods in Micromechanics of Composite Materials," Applied Mechanics Review, 54(1), pp. 1-47, 2001.
5. Buryachenko, V.A. and Bechel, V.T., "A Volume Integral Equation Method for Multiple Inclusion Interaction Problems," Compos. Sci. Technol., 60, pp. 2465-2469, 2000.
6. Buryachenko, V.A. and Rammerstorfer, F.G., "Local Effective Thermoelastic Properties of Graded Random Structure Composites," Arch. Appl. Mech., 71, pp. 249-272, 2001.
7. Buryachenko, V.A. and Rammerstorfer, F.G., "On the Thermostatics of Composites With Coated Random Distributed Inclusions," Int. J. Solids Struct., 37, pp. 3177-3200, 2000.
8. Hall, R.B., "Methods in Entropic Thermomechanics," Composites Science and Technology, Vol. 60, No. 12-13, pp. 2581-2599, 2000.
9. Larve, E.V. and Pagano, N.J., "Singular Full-Field Stresses in Composite Laminates With Open Holes," Int. J. Solids Structures, Vol. 38, pp. 1-24, 2001.
10. Mollenhauer, D.H. and Reifsnider, K.L., "Interlaminar Deformation Along the Cylindrical Surface of a Hole in Laminated Composites—Experimental Analysis by Moiré Interferometry," Journal of Composites Technology and Research, Vol. 23, No. 3, pp. 177-188, July 2001.
11. Pagano, N.J. and Yuan, F.G., "The Significance of Effective Modulus Theory (Homogenization) in Composite Laminate Mechanics," Composites Science and Technology, 60, pp. 2471-2488, 2000.
12. Pochiraju, K.V., Tandon, G.P., and Pagano, N.J., "Analyses of Single Fiber Pushout Considering Interfacial Friction and Adhesion," Journal of the Mechanics and Physics of Solids, Vol. 49, pp. 2307-2338, 2001.
13. Raghavan, P., Moorthy, S., Ghosh, S., and Pagano, N.J., "Revisiting the Composite Laminate Problem With an Adaptive Multi-level Computational Model," Composites Science and Technology, 61, No. 8, pp. 1017-1040, 2001.
14. Roy, A.K. and Sih, S., "Development of a Three-Dimensional Mixed Variational Model for Woven Composites: Part I—Mathematical Formulation," International Journal of Solids and Structures, Vol. 38, pp. 5935-5947, 2001.
15. Sih, S. and Roy, A.K., "Development of a Three-Dimensional Mixed Variational Model for Woven Composites: Part II—Numerical Solution and Validation," International Journal of Solids and Structures, Vol. 38, pp. 5949-5962, 2001.

15. Tandon, G.P., Buchanan, D., Pagano, N.J., and John, R., "Analytical and Experimental Characterization of Thermo-Mechanical Properties of a Damaged Woven Oxide-Oxide Composite," Ceramic Engineering and Science Proceedings, 25th Annual International Conference on Advanced Ceramics and Composites, American Ceramic Society, Vol. 22, Issue 3, pp. 687-694, 2001.
16. Tandon, G.P., Kim, R.Y., and Bechel, V.T., "Evaluation of Interfacial Normal Strength in a SCS-0/Epoxy Composite With Cruciform Specimens," Composite Science and Technology, 60, pp. 2281-2295, 2000.
17. T. A. Parthasarathy, R. J. Kerans, and N. J. Pagano, Effective Fiber Properties to Incorporate Coating Thermoelastic Effects in Fiber/Matrix Composite Models, J. American Ceramic Society, Vol.82 (1999).
18. E. A. Iarve and N. J. Pagano, Singular Full-Field Stresses in Composite Laminates with Open Holes, Int. J. Solids and Structures (in press).
19. G.A. Schoeppner and N.J. Pagano, 3-D Thermoelastic Moduli and Saturation Crack Density for Cross-Ply Laminates with Transverse Cracks, International Journal of Damage Mechanics, Vol. 8, 1999
20. R. E. Dutton, N. J. Pagano, R. Y. Kim, and T. A. Parthasarathy, Modeling the Ultimate Tensile Strength of Unidirectional Glass Matrix Composites, J. American Ceramic Society, Vol. 83 (2000).
21. N. J. Pagano and G. A. Schoeppner, Delamination of Polymer Matrix Composite Materials: Problems and Assessment, Chapter 14, Comprehensive Composite Materials, Ed. R. Talreja, Elsevier, (in press) 2000.
22. V.A. Buryachenko and N.J. Pagano, Multiscale Analysis of Multiple Inclusion Problem: 1. Finite Number of Interacting Inclusions, submitted to International Journal of Solids and Structures.
23. G. P. Tandon, R. Y. Kim and V. T. Bechel, "Evaluation of Interfacial Normal Strength in SCS-0/Epoxy Composite Using Cruciform Specimen ", Composites Science and Technology (in press)
24. Bechel, V.T. and G. P. Tandon, "Interface Strength Measured Away from Free Edge, Cracktip, and Corner Singularities" submitted to Experimental Mechanics.
25. Schoeppner, G.A. and Abrate, S., "Delamination Threshold Loads for Low Velocity Impact on Composite Laminates," Composites Part A, Applied Science and Manufacturing 2000, 31, 903-915
26. Iarve, E. V. Asymptotically Exact Stresses in Laminates with Rigid Fastener. Composite Science and Technology. (in press)
27. Iarve, E. V., & Mollenhauer, D. Three-Dimensional Stress Analysis and Failure Prediction in Filled Hole Laminates, ASTM Paper, (to appear)
28. Mollenhauer, D. and K. Reifsnider, " Measurements of Interlaminar Deformation Along the Cylindrical Surface of a Hole in Laminated Composite Materials by Moiré Interferometry," Composites Science and Technology, (In Press)
29. Mollenhauer, D. "Interlaminar Deformation Along the Cylindrical Surface of a Hole in Laminated Composite Tensile Specimens," a chapter in The Handbook of Moiré Measurements, In Press.
30. Buryachenko V. A., Rammerstorfer F., G. Plankenstein A. F. A local theory of elastoplastic deformation of two-phase metal matrix random structure composites. ASME J. Appl. Mech. (Accepted, 2000).

31. Buryachenko V. A., Rammerstorfer F. G. On the thermoelasticity of random structure particulate composites. Z. angew. Mech. Phys. 1999, 50, 934-947.
32. Buryachenko V. A., Rammerstorfer F. G. On the thermostatics of composites with coated random distributed inclusions. Int. J. Solids Struct. 2000, 37, 3177-3200.
33. Buryachenko V. A. Thermo-elastoplastic deformation of elastically homogeneous materials with a random field of inclusions. Int. J. Plasticity, 1999, 15, 687-720.
34. Buryachenko V. A. Triply periodical particulate matrix composites in varying external stress fields. Int. J. Solids Struct., 1999, 36, 3837-3859.
35. Buryachenko V. A. Effective thermoelastic properties of graded doubly periodic particulate matrix composites in varying stress fields. Int. J. Solids Struct. 1999, 36, 3861-3885.
36. Buryachenko V. A. Self-consistent and related methods in micromechanics of composite materials. Applied Mechanics Review. (Invited Rev. Article, 537 ref. Accepted, 2000)

2001

FY01 PUBLICATIONS AND PRESENTATIONS

“Environmental Effects on Polymer Matrix Composites”

Published in Unreviewed Publications:

David B. Curliss, “US Air Force High Temperature Composites Overview,” High Temple Workshop XXI, Paper C, Clearwater Beach, FL, 2001.

Katie E. G. Thorp, David B. Curliss “Cure and Degradation of Norbornene-Terminated Addition Polyimides,” High Temple Workshop XXI, Paper L, Clearwater Beach, FL, 2001.

Myong Ahn, David B. Curliss, Katie E. G. Thorp, and William A. Price, “Wide-line Deuterium NMR Line Shape Investigations of Polyimide Resins,” High Temple Workshop XXI, Paper AA, Clearwater Beach, FL, 2001.

Jason E. Lincoln, Roger J. Morgan, and E. Eugene Shin, “Critical Structure-Property-Processing Parameters and the Effects of Thermal History on the Performance of Polyimide and Bismaleimide Composite Matrices”, Proceedings of the American Society for Composites 15th Technical Conference, 1103 (2000)

Jason E. Lincoln, William A. Price, David B. Curliss, and Roger J. Morgan, “Structure-Property-Processing Characterization of AFR-PEPA-N Imide Oligomers and Their Crosslinked Polyimides,” High Temple Workshop XXI, Paper I (2001)

Published in Reviewed Publications:

David B. Curliss, “Composite Materials,” in Encyclopedia of Physical Science and Technology, Academic Press, 2001.

Jason E. Lincoln, Roger J. Morgan, and E. Eugene Shin, “Fundamental Investigation of Cure-Induced Microcracking in Carbon Fiber/Bismaleimide Cross-Ply Laminates,” Polymer Composites, 22, (3), 397-419 (2001)

Jason E. Lincoln, Roger J. Morgan, and E. Eugene Shin, “Structure-Property-Processing and Hygrothermal Durability Characterization of BMPM/DABPA Polymer Matrices and Their Carbon Fiber Composites: A Review,” Polymer, To be submitted (2001)

Jason E. Lincoln, Roger J. Morgan, and E. Eugene Shin, “Effect of Thermal History on the Deformation and Failure of Polyimides,” Journal of Polymer Science Part B: Polymer Physics Edition, In Press (2001)

Roger J. Morgan, E. Eugene Shin, Jason E. Lincoln, and Jiang Zhou, "Overview of Polymer Matrix Composites Performance and Materials Development for Aerospace Applications," SAMPE Journal, 37, (2), 102 (2001) "Feature Article"

Roger J. Morgan, E. Eugene Shin, and Jason E. Lincoln, "Thermal Properties of Polymer Matrix Fibrous Composites," In Thermal Analysis of Polymers, S. Chen, ed., Elsevier, In Press (2001)

Katie E. G. Thorp, David B. Curliss, and William A. Price, "The Mechanism and Kinetics of Hydrolytic Degradation in Norbornene-Terminated Addition Polyimides," Macromolecules, to be submitted (2001).

Katie E. G. Thorp, David B. Curliss, and Brett Cowans, "Cure Reaction Mechanisms and Processing Dependence in Norbornene-Terminated Addition Polyimides," Macromolecules, to be submitted (2001).

Awards:

Jason E. Lincoln - "Best Paper Award", American Society for Composites 16th Technical Conference, Environmental Effects Division, Virginia Polytechnic Institute

Katie E. G. Thorp - 2001 Federal Employee of the Year, Scientific/Engineering/Medical/Legal, International Personnel Management Association, Dayton Chapter

David B. Curliss and Katie E. G. Thorp – AFRL/ML, 2000 Robert T. Schwartz Engineering Achievement Award for "Environmental Durability of Addition Polyimide Matrix Composites for Air Force Engine and Airframe Applications"

Invited Seminars:

David B. Curliss "High Performance Composite Materials Research at the Air Force Research Laboratory Materials and Manufacturing Directorate," Indiana State University Chemistry Departmental Seminar, March 27, 2001.

Professional Activities:

Katie E. G. Thorp, First Vice Chair SAMPE Midwest Chapter

"New World Vista: Ballistic Damage Tolerant Composite Materials for UCAV Structural Applications"

Referred Publications:

Chenggang Chen, David Curliss "Resin Matrix Composites: Organoclay-Aerospace Epoxy Nanocomposites, Part II" SAMPE Journal, Vol. 37, No. 5, 11-18, September/October, 2001.

Brian P. Rice, Chenggang Chen, Larry Cloos, David Curliss "Carbon Fiber Composite: Organoclay-Aerospace Epoxy Nanocomposites, Part I" SAMPE Journal, Vol. 37, No. 5, 7-9, September/October, 2001.

Hao Fong, Richard A. Vaia, Jeffrey H. Sanders, Derek Lincoln, A. J. Vreugdenhil, Weidong Liu, John Bultman and Chenggang Chen "Self-Passivation of Polymer-Layered Silicate Nanocomposites" Chemistry of Materials, 4123-4129, Nov. 2001.

Non-Refereed Publications:

Chenggang Chen and David Curliss "Processing, Dynamic Studies and Properties of Exfoliated Aerospace Epoxy-Organoclay Nanocomposites" Nanophase and Nanocomposite Materials IV, Proceedings of the Materials Research Society Symposium, Vol. 701, 2001.

Chenggang Chen and David Curliss "Organoclay-Aerospace Epoxy Nanocomposites", Proceedings of 46th SAMPE Symposium, "2001: A Materials and Processes Odyssey", Vol. 46, 362-374, 2001.

Brian P. Rice, Chenggang Chen, Lary Cloos, and David Curliss "Carbon Fiber Composites Prepared From Organoclay-Aerospace Epoxy Nanocomposites", Proceedings of 46th SAMPE Symposium, "2001: A Materials and Processes Odyssey", Vol. 46, 355-361, 2001.

Chenggang Chen, Brian P. Rice, and David Curliss "High-Performance Fiber-Reinforced Composites with Polymer-Silicate Nanocomposite Matrix", 221st American Chemical Society National Spring Meeting, April 2, 2001, SanDiego, California, USA.

FY01 Publications and Presentations

Refereed Articles

1. Buryachenko, V.A., "Internal Residual Stresses in Elastically Homogeneous Solids: I. Statistically Homogeneous Stress Fluctuations," Int. J. Solids Struct., 37, pp. 4185-4210, 2000.
2. Buryachenko, V.A., "Internal Residual Stresses in Elastically Homogeneous Solids: II. Stress Fluctuations Near a Crack Tip and Effective Energy Release Rate," Int. J. Solids Struct., 37, pp. 4211-4238, 2000.
3. Buryachenko, V.A., "Locality Principle and General Integral Equations of Micromechanics of Composite Materials," Math. Mech. of Solids, 6, pp. 299-321, 2001.
4. Buryachenko, V.A., "Multiparticle Effective Field and Related Methods in Micromechanics of Composite Materials," Applied Mechanics Review, 54(1), pp. 1-47, 2001.
5. Buryachenko, V.A. and Bechel, V.T., "A Volume Integral Equation Method for Multiple Inclusion Interaction Problems," Compos. Sci. Technol., 60, pp. 2465-2469, 2000.
6. Buryachenko, V.A. and Rammerstorfer, F.G., "Local Effective Thermoelastic Properties of Graded Random Structure Composites," Arch. Appl. Mech., 71, pp. 249-272, 2001.
7. Buryachenko, V.A. and Rammerstorfer, F.G., "On the Thermostatics of Composites With Coated Random Distributed Inclusions," Int. J. Solids Struct., 37, pp. 3177-3200, 2000.
8. Hall, R.B., "Methods in Entropic Thermomechanics," Composites Science and Technology, Vol. 60, No. 12-13, pp. 2581-2599, 2000.
9. Iarve, E.V. and Pagano, N.J., "Singular Full-Field Stresses in Composite Laminates With Open Holes," Int. J. Solids Structures, Vol. 38, pp. 1-24, 2001.
10. Mollenhauer, D.H. and Reifsneider, K.L., "Interlaminar Deformation Along the Cylindrical Surface of a Hole in Laminated Composites—Experimental Analysis by Moiré Interferometry," Journal of Composites Technology and Research, Vol. 23, No. 3, pp. 177-188, July 2001.
11. Pagano, N.J. and Yuan, F.G., "The Significance of Effective Modulus Theory (Homogenization) in Composite Laminate Mechanics," Composites Science and Technology, 60, pp. 2471-2488, 2000.
12. Pochiraju, K.V., Tandon, G.P., and Pagano, N.J., "Analyses of Single Fiber Pushout Considering Interfacial Friction and Adhesion," Journal of the Mechanics and Physics of Solids, Vol. 49, pp. 2307-2338, 2001.
12. Raghavan, P., Moorthy, S., Ghosh, S., and Pagano, N.J., "Revisiting the Composite Laminate Problem With an Adaptive Multi-level Computational Model," Composites Science and Technology, 61, No. 8, pp. 1017-1040, 2001.

13. Roy, A.K. and Sihn, S., "Development of a Three-Dimensional Mixed Variational Model for Woven Composites: Part I—Mathematical Formulation," International Journal of Solids and Structures, Vol. 38, pp. 5935-5947, 2001.
14. Sihn, S. and Roy, A.K., "Development of a Three-Dimensional Mixed Variational Model for Woven Composites: Part II—Numerical Solution and Validation," International Journal of Solids and Structures, Vol. 38, pp. 5949-5962, 2001.
15. Tandon, G.P., Buchanan, D., Pagano, N.J., and John, R., "Analytical and Experimental Characterization of Thermo-Mechanical Properties of a Damaged Woven Oxide-Oxide Composite," Ceramic Engineering and Science Proceedings, 25th Annual International Conference on Advanced Ceramics and Composites, American Ceramic Society, Vol. 22, Issue 3, pp. 687-694, 2001.
16. Tandon, G.P., Kim, R.Y., and Bechel, V.T., "Evaluation of Interfacial Normal Strength in a SCS-0/Epoxy Composite With Cruciform Specimens," Composite Science and Technology, 60, pp. 2281-2295, 2000.

Conference Proceedings and Reports

1. Bechel, V.T. and Tandon, G.P., "Interfacial Toughness Measurement for a Model SiC/Epoxy Composite," Proceedings of the 2001 Society of Experimental Mechanics Conference, Portland OR, June 4-6, 2001.
2. Bechel, V.T. and Tandon, G.P., "Interfacial Toughness Measurement for a Model SiC/Epoxy Composite," Proceedings of SEM—X International Congress on Experimental Mechanics, San Diego CA, 2001.
3. Bechel, V.T., Janke, C., Wilenski, M., and Tandon, G.P., "Constituent Level Examination of an E-Beam Cured Graphite/Epoxy Composite," Proceedings of the 2001 Society for the Advancement of Materials and Process Engineering Conference, Long Beach CA, May 6-10, 2001.
4. Bowman, K.B. and Mollenhauer, D.H., "Experimental Investigation of Free Edge Residual Stresses in Layered Materials," Proceedings of the 42nd AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics, and Materials Conference and Exhibit, Seattle WA, April 16-19, 2001.
5. Bowman, K.B. and Mollenhauer, D.H., "Experimental Investigation of Residual Stresses in Layered Materials Using Moiré Interferometry," Polymeric Materials for Microelectronics and Photonics Applications: Mechanics, Physics, Reliability, Processing, London, UK, December 2000.
6. Buryachenko, V.A., "Micromechanics of Non-local Effects in Heterogeneous Materials," 2001 Mechanics and Materials Summer Conference, La Jolla CA, June 2001.
7. Buryachenko, V.A., Pagano, N.J., "Multiscale Modeling for Multi-interacting Inclusion Problems Including Edge Effect," 2001 Mechanics and Materials Summer Conference, La Jolla CA, June 2001.

8. Donaldson, S.L. and Kim, R.Y., "Mode I Fracture of a Carbon Fiber-Reinforced Bismaleimide Composite at Cryogenic Temperatures," Proceedings of the 2001 Society for the Advancement of Materials and Process Engineering Conference, Long Beach CA, May 6-10, 2001.
9. Foster, D., "The Feasibility of a Composite Highway Bridge," ACUN-3 International Conference on Technology Convergence in Composite Applications, Sydney, Australia, February 5-9, 2001.
10. Iarve, E.V. and Kim, R., "Three-Dimensional Modeling and Experimental Investigation of Damage Evolution and Hole Size Effect on Strength of Composite Laminates," ASME Annual Winter Meeting, Orlando FL, November 5-10, 2000.
11. Iarve, E.V., Kim, R., and Mollenhauer, D.H., "Analytical/Experimental Examination of Cracks in a 0° Composite Laminate Containing a Central Hole," Proceedings of the American Society for Composites, 16th Technical Conference, Blacksburg VA, September 2001.
12. Kim, R.Y. and Donaldson, S.L., "Experimental Observation of Microcracking of Cross-ply Laminate Under Cryogenic Temperature," Space 2001: The Odyssey Continues Conference & Exposition, Albuquerque NM, August 2001.
13. Mollenhauer, D.H. and Camping, J.D., "Multi-Layered Polymer Mirror Experiment," Proceedings of the 42nd AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics, and Materials Conference and Exhibit, Seattle WA, April 16-19, 2001.
14. Schoeppner, G.A., Kim, R., and Donaldson, S.L., "Steady State Cracking of PMCs at Cryogenic Temperatures," Proceedings of the 42nd AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics, and Materials Conference and Exhibit, Seattle WA, April 16-19, 2001.
15. Schoeppner, G.A., Mollenhauer, D.H., and Iarve, E.V., "3D Spline Variational Analysis of a Composite Double-Lap Shear Joint," Proceedings of the 2001 Society for the Advancement of Materials and Process Engineering Conference, Long Beach CA, May 6-10, 2001.
16. Sihn, S. and Mollenhauer, D.H., "Parametric Design, Analysis, and Testing of a Model Woven Composite With a Cruciform Geometric Configuration," Proceedings of the American Society for Composites, 16th Technical Conference, Blacksburg VA, September 9-12, 2001.
17. Sihn, S. and Roy, A.K., "Modeling and Stress Analysis of Open-Cell Carbon Foam," Proceedings of the 2001 Society for the Advancement of Materials and Process Engineering Conference, Long Beach CA, May 6-10, 2001.
18. Sihn, S. and Roy, A.K., "Prediction of Stiffness and Strength of Plain Weave Composites By Mixed Finite Element Method," The 2000 ASME International Mechanical Engineering Congress & Exposition, Orlando FL, November 5-10, 2000.

19. Tandon, G.P., Kim, R.Y., and Bechel, V.T., "Mixed-Mode Interface Failure Criteria Using Cruciform Geometry," Proceedings of the 2001 American Society of Composites Conference, Blacksburg VA, September 2001.

Accepted/Submitted Publications

1. Bechel, V.T. and Tandon, G.P., "Characterization of Interfacial Failure Using a Reflected Light Technique," Experimental Mechanics, to be published.
2. Bechel, V.T. and Tandon, G.P., "Modified Cruciform Test for Application to Graphite/Epoxy Composites," Mechanics of Composite Materials and Structures, to be published.
3. Bowman, K.B. and Mollenhauer, D.H., "Determination of Residual Stresses on Free Edges of Layered Materials Using the Material Removal for Free Edge Evaluation (MRFEE) Method," Proceedings of the Third Australasian Congress on Applied Mechanics, Sydney, Australia, February 2002.
4. Buryachenko, V.A., "A Simple Method of Analysis of Multiple Inclusion Interaction Problem," Int. J. Comput. Civil & Structural Engng., in press.
5. Buryachenko, V.A., "Multiparticle Effective Field and Related Methods in Micromechanics of Random Composite Materials," Math. Mech. of Solids, to be published.
6. Buryachenko, V.A. and Pagano, N.J., "Multiscale Analysis of Multiple Interacting Inclusions Problem: Finite Number of Interacting Inclusions," International Journal of Solids and Structures, submitted for publication.
7. Buryachenko, V.A. and Pagano, N.J., "Nonlocal Models of Stress Concentrations and Effective Thermoelastic Properties of Random Structure Composites," International Journal of Solids and Structures, submitted for publication.
8. Buryachenko, V.A., Rammerstorfer F. G., and Plankenstein A.F., "A Local Theory of Elastoplastic Deformation of Two-Phase Metal Matrix Random Structure Composites," ASME J. Appl. Mech., in press.
9. Crasto, A.S., Kim, R.Y., and Russell, J.D., "In Situ Monitoring of Residual Strain Development During Composite Cure," Polymer Composites, to be published.
10. Iarve, E.V. and Kim, R., "Three-Dimensional Fracture Analysis and Experimental Investigation of Model Unidirectional Discontinuous Tow Composite Laminates," Thermoplastic Composites, to be published.
11. Iarve, E.V. and Mollenhauer, D.H., "Full-Field Singular Stresses in a Composite Laminate Weakened by a Cylindrical Cavity: Theory and Experiment," Advanced Composite Materials, to be published..

12. Iarve, E.V., Mollenhauer, D.H., and Kim, R., "Transverse Damage Induced Stress Redistribution in Open Hole Composite Laminates," Proceedings of the Third Australasian Congress on Applied Mechanics, Sydney, Australia, February 2002.
13. Mollenhauer, D.H. and Camping, J.D., "Multi-Layered Polymer Mirror Experiment," Journal of Spacecraft and Rockets, to be published.
14. Mollenhauer, D.H., Schoeppner, G.A., and Iarve, E.I., "Strain Measurement and Prediction in a Composite Double-Lap Shear Bonded Joint," Proceedings of the Third Australasian Congress on Applied Mechanics, Sydney, Australia, February 2002.
15. Mukhopadhyay, S.M., Mahadev, N., Joshi, P., Roy, A.K., Kearns, K., Anderson, D., "Structural Investigation of Graphitic Foam," Applied Physics, submitted for publication.
16. Roy, A.K., patent application, Serial Number 09/896,194, "Optical Method for Measuring Poisson's Ratio."
17. Roy, A.K. and J.D. Camping, "Development of a Portable Shear Test Fixture for Low Modulus (Foam) Materials," Experimental Mechanics, to be published.
18. Schoeppner, G.A., Mollenhauer, D.H., and Bowman, K.B., "Residual Stress Prediction and Measurement in Composite Bonded Joint Adhesive," Proceedings of the Third Australasian Congress on Applied Mechanics, Sydney, Australia, February 2002.
19. Voevodin, A.A., Iarve, E.V., Ragland, W.R., Zabinski, J.S., and Donaldson, S., "Stress Analysis and In-situ Fracture Observation of Wear Protective Multilayer Coatings in Contact Loading," Surface and Coatings Technology, to be published.

Invited Lectures and Presentations

1. Foster, D., "The Feasibility of a Composite Highway Bridge," ACUN-3 International Conference on Technology Convergence in Composite Applications, Sydney, Australia, February 5-9, 2001.
2. Schoeppner, G., 2000 UCAV Workshop, Holiday Inn and Conference Center, Fairborn OH.
3. Schoeppner, G., DoD Composite Repair Workshop V, Coeur d'Alene ID, November 14-16, 2000.
4. Sihn, S. and Roy, A.K., "Three-Dimensional Stress and Strain Field Influencing Damage in Woven Composites," International Conference on Materials for Advanced Technologies (ICMAT), July 1-6, 2001, Singapore.
5. Tandon, G.P., Kim, R.Y., Rice, B.P., "Analyzing Nanocomposites Using Continuum Mechanics Approaches," Air Force Workshop on Nanocomposites, Blacksburg VA, September 12-13, 2001.

Presentations

1. Bechel, V., "3D Spline Variational Analysis of a Composite Double-Lap Shear Joint," 46th International SAMPE Symposium & Exhibition, Long Beach CA, May 6-10, 2001.
2. Bechel, V., "Constituent Level Examination of an E-Beam Cured Graphite/Epoxy Composite," 46th International SAMPE Symposium & Exhibition, Long Beach CA, May 6-10, 2001.
3. Bechel, V., "Constituent Level Examination of an E-Beam Cured Graphite/Epoxy Composite," National Space and Missile Materials Symposium, Monterey CA, June 2001.
4. Bechel, V., "Interfacial Toughness Measurement for a Model SiC/Epoxy Composite," Society of Experimental Mechanics Conference, Portland OR, June 2001.
5. Bechel, V.T. and Tandon, G.P., "Interfacial Toughness Measurement for a Model SiC/Epoxy Composite" SEM—X, San Diego CA, 2001.
6. Bechel, V.T., Janke, C., Wilenski, M., and Tandon, G.P., "Constituent Level Examination of an E-Beam Cured Graphite/Epoxy Composite," 46th International SAMPE Symposium & Exhibition, Long Beach CA, May 6-10, 2001
7. Donaldson, S.L. and Kim, R.Y., "Delamination of Composite Laminate at Cryogenic Temperatures," National Space and Missile Materials Symposium, Monterey CA, June 2001.
8. Foster, D., "Health Monitoring of the Tech 21 All Composite Vehicle Bridge," 2001 Transportation Research Board A2C07 Committee, January 10, 2001.
9. Iarve, E.V., "Spline Variation Elastic Laminate Technology for Composite Bolted Joints," Seventh SVELT Workshop, Wright-Patterson AFB OH, October 2000.
10. Iarve, E.V. and Kim, R., "Three-Dimensional Modeling and Experimental Investigation of Damage Evolution and Hole Size Effect on Strength of Composite Laminates," ASME Annual Winter Meeting, Orlando FL, November 5-10, 2000.
11. Iarve, E.V., Kim, R., and Mollenhauer, D.H., "Analytical Experimental Examination of Cracks in a 0° Composite Laminate Containing a Central Hole," American Society for Composites 16th Technical Conference, Blacksburg VA, September 2001.
12. Mollenhauer, D.H. and Camping, J.D., "Multi-Layered Polymer Mirror Experiment and Polymer Spun-Cast Mirror Effort," National Space and Missile Materials Symposium, Monterey CA, June 2001.
13. Pochiraju, K.V., Tandon, G.P., and Pagano, N.J., "A Methodology for Bi-Material Interface Strength Characterization," Symposium on Microstructural and Mechanical Property Relationships in Advanced Composites, IMECE, Orlando FL, November 5-10, 2000.

14. Schoeppner, G., 42nd AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics, and Materials Conference and Exhibit, Seattle WA, April 16-19, 2001
15. Sihn, S., "B-SAM for Woven Composites," B-SAM Workshop, Materials and Manufacturing Directorate, Air Force Research Laboratory, Wright-Patterson AFB, October 25, 2000.
16. Sihn, S., "Mechanical Analysis of Carbon Foam," 2001 US-Korea Conference on Science, Technology, and Entrepreneurship, Cambridge MA, August 10-12, 2001.
17. Sihn, S. and Mollenhauer, D., "Parametric Design, Analysis, and Testing of a Model Woven Composite with a Cruciform Geometric Configuration," American Society for Composites 16th Annual Technical Conference, Blacksburg VA, September 9-12, 2001.
18. Sihn, S. and Roy, A.K., "Mechanics and Modeling of Graphitic Foam," Carbon Foam Workshop, Materials and Manufacturing Directorate, Air Force Research Laboratory, Wright-Patterson AFB, November 2-3, 2000.
19. Sihn, S. and Roy, A.K., "Modeling and Stress Analysis of Open-Cell Carbon Foam," The 46th International SAMPE Symposium & Exhibition, Long Beach CA, May 6-10, 2001.
20. Sihn, S. and Roy, A.K., "Prediction of Stiffness and Strength of Plain Weave Composites By Mixed Finite Element Method," The 2000 ASME International Mechanical Engineering Congress & Exposition, Orlando FL, November 5-10, 2000.
21. Tandon, G.P., Buchanan, D., Pagano, N.J., and John, R., "Analytical and Experimental Characterization of Thermo-Mechanical Properties of a Damaged Woven Oxide-Oxide Composite," 25th Annual International Conference on Advanced Ceramics and Composites, American Ceramic Society, Cocoa Beach FL, January 21-26, 2001.
22. Tandon, G.P., Kim, R.Y., and Bechel, V.T., "Mixed-Mode Failure Criteria Using Cruciform Geometry," 16th Annual Technical Conference of the American Society for Composites, Blacksburg VA, September 9-12, 2001.

Awards & Honors

Bechel, V. and Donaldson, S., Winner, 2001 Air Force Research Laboratory General Yates Award for Technology Transfer, for our design and testing of the composite forearm crutch.

Bechel, V. and Donaldson, S., Honorable Mention, 2001 Ferguson Award for Technology Transfer (AFRL), for our design and testing of the composite forearm crutch.